# American Aviation

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OCTOBER 24, 1955

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Fourth Annual Engineering & Development Issue

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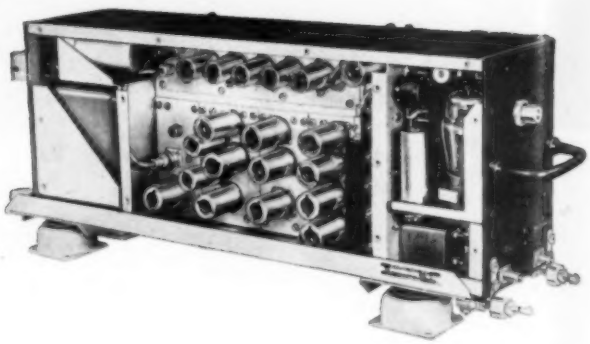
# SPECIAL REPORT

# ON NEW RADAR SAFETY BEACON

**An announcement of vital interest to airline and corporate aircraft management, engineering and flying personnel, concerning a significant contribution toward greater safety and efficiency of operations.**



HERE AT LAST! Wilcox is proud to announce the acquisition of the exclusive, world-wide manufacturing and distribution rights for the airborne Air Traffic Control Transponder (Wilcox Model 714 Radar Safety Beacon) designed by Melpar, Inc., (subsidiary research organization of Westinghouse Air Brake Company).

The unit is the result of three years of intensive research by Melpar engineers under the direction of Vernon Weihe and Robert Boymel. It was designed to ARINC characteristic No. 532.

It promises far more effective Airport Surveillance Radar, especially in view of the fact that CAA is now equipping major traffic centers with ground interrogators.

ASR HAS HAD PROBLEMS. Airport Surveil lance Radar has been hindered by the difficulty of getting quick, positive identification of each aircraft on the radar scope. Target surfaces are often not large enough for good indication. Bad weather affects readings. Identification has been possible only by time-consuming flight maneuvers.

BUT NOW, THE SOLUTION IS HERE! The Wilcox Model 714 RADAR SAFETY BEACON erases most limitations of ASR. It's an inexpensive airborne transponder. A signal from the ground radar hits equipment in the aircraft, triggers a transmitter which sends the coded signal back. Good, clear, strong indications on the radar scope are virtually unaffected by sleet, snow, thunderstorms, congested traffic conditions at all distances up to the limit of radar range, on all types of aircraft!

THE WILCOX RADAR SAFETY BEACON TAKES A BIG LOAD OFF THE PILOT'S BACK! How? Say you're a pilot of an aircraft equipped with the Wilcox Model 714 RSB...

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6. You know the pattern is more flexible! Errors in speed or position can be spotted and corrected faster. The radar man can pull you out of the pattern and land you--even at a strange airport--quickly--in case of emergency!
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HAS IT BEEN PROVED? Several thousand hours of flight time have been accumulated on the Wilcox Type 714 Radar Safety Beacon by Lake Central Airlines! They installed six prototypes on aircraft operated in regular scheduled service.

WHEN CAN YOU GET THEM? Production and delivery is scheduled for late 1955. This gives you ample time to install, coinciding with CAA schedule for interrogators now being installed on ASR radar at major terminals.

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Send for descriptive literature on the Wilcox Type 714 Radar Safety Beacon. Contact Wilcox Electric Company, Fourteenth and Chestnut, Kansas City 27, Mo. BEnton 0700.

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# To the Man in the Secret Drafting Room

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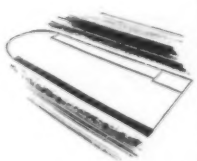

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**4th Annual Engineering & Development Issue**

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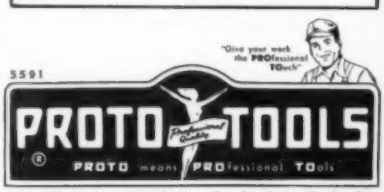


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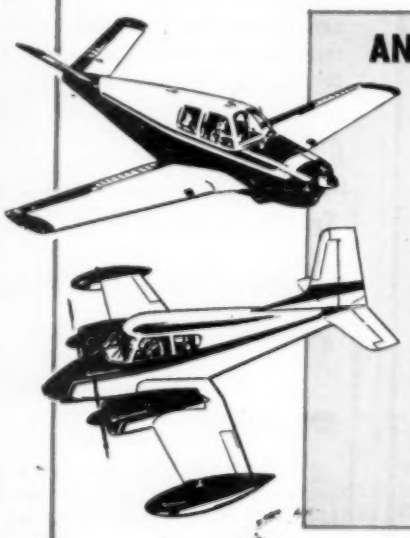

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# Letters

## 'Wonderful Job'

To the Editor:

Your nice article on Aero Design in the September 26 issue of AMERICAN AVIATION Magazine has been received very well by everyone here at Aero. May I pass on the personal thanks of Mr. Pew, Mr. Amis and our sales manager, Mr. Wootten, for the very comprehensive piece of writing represented in this article. Thank you very much for a wonderful job.

HAL WEATHERLY
*Public Relations*
Aero Design & Engineering Co.
Bethany, Okla.

## Drones and Dollars

To the Editor:

We were naturally very much intrigued with the suggestion in Fred Hunter's West Coast Talk column in the September 26 issue of AMERICAN AVIATION Magazine suggesting that the Nike be fired against a B-47 jet bomber converted to a drone.

We certainly concur in the suggestion that our whole defense system needs to be proved against realistic targets—meaning, of course, jet airplanes flying in the 600 mph range at high altitude. But it isn't necessary to use a B-47 for such target work. Ryan's Firebee jet target was designed for just such assignments and is already available to the military services. The cost: somewhere around 1/40th the cost of a B-47.

So, instead of firing at one B-47 drone our military services can get 25 to 50 times the amount of practice for the same dollar outlay, by using Firebees.

WILLIAM WAGNER, DIRECTOR
Public & Employee Relations
Ryan Aeronautical Company
San Diego, Calif.

## Congratulations

To the Editor:

I want to congratulate you and the members of your publication on your excellent coverage of the recent TACAN demonstration. It was one of the finest stories that I have seen in some time. We here at FTL are greatly indebted to you for your cooperation.

Incidentally, would it be possible to obtain a few copies of the recent sales promotion brochure in which you so generously included the story on the TACAN symposium? Gen. P. C. Sandretto liked it very much.

E. J. FELESINA
Public Relations
Federal Telecommunication Laboratories
Nutley, N. J.

## Garden of Remembrance

To the Editor:

I have just read the article of life in the Russian Sector of Berlin by Wayne Parrish in the Sept. 12 issue of your magazine. In the third paragraph he says, "But the Russians know how to build monuments" and describes the Garden of Remembrance. On further

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**investigation, I believe he would have learned that the Garden of Remembrance was built by Germans with German materials, with money raised by "voluntary contributions" from East Germany.**

**No doubt the Russians can build monuments, but credit should be given where credit is due.**


**MRS. IMOGENE OLSON**
**Star Route, Box 784**
**Spenard, Alaska**


***But let's not forget, too, that the German "contribution" to the monument wasn't exactly by choice. The Russians designed the monument and directed its construction.—Ed.***

## Books

### Thermodynamics and Physics of Matter.

*Edited by F. D. Rossini. Published by Princeton University Press, First volume of a series on high speed aerodynamics and jet propulsion. 830 pp. Price: $15.*

Fundamentals of thermodynamics and such subjects as molecular structure, bond energies and activation energies, statistical mechanics and the kinetic theory of gases are discussed in this first volume of a series that will ultimately comprise the cumulative work of more than 100 leading scientists representing the many branches of aeronautical sciences. The book was written with the express purpose of providing aeronautical scientists with a working knowledge of thermodynamics as it applies to their own area of study. It contains more than 150 line drawings.

### The Third Service.

*By Air Chief Marshal Sir Philip Joubert de la Ferte. Published by Thames and Hudson Ltd., 224 High Holborn, London W. C. 1, England. 274 pages. Price: $2.95.*

This is a highly controversial book written by an RAF leader to let the British public know how air force policies originate and are carried out. Its basic theme is the internecine struggle for power between the three armed services, and descriptions are given of recurrent efforts of the politically powerful Royal Navy to gain complete control over the sea, as well as Army efforts to use the RAF for its own limited tactical ends.

From his inside knowledge, Sir Philip reveals behind-the-scenes causes for many RAF developments and sounds a note of warning on political dangers to the RAF as a strong and independent entity.

This is a hard-hitting yet well reasoned and logical book that should be read by everyone with an interest in the U. K. fighting services in general and the RAF in particular . . . J. H. S.

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# Production Spotlight

**• Controversy over whether a Manhattan Project-type operation is needed to accelerate development of the intercontinental ballistic missile continues in the Pentagon. Feeling is that a blank check on funds (as happened with the A-bomb) would speed the ICBM.**

• With phaseout of the North American F-86D, the Northrop F-89D becomes the only subsonic interceptor still in production. Convair and McDonnell have been told to get their F-102 and F-101B supersonic interceptors delivered to the Air Defense Command as soon as possible.

**• If USAF goes through with present planning to order development of a second intercontinental ballistic missile, an inland plant will be chosen to produce it even though the two companies still in the running have their principal production facilities located on each coast. Convair's Atlas, however, is reported slightly ahead of schedule.**

• France's Avions Marcel Dassault has modified the design of the Armstrong-Siddeley Viper so as to make it a normal-life instead of a short-life engine. The French version of the Viper is designated the MD 30. Dassault has also designed an afterburner for the engine. Dassault acquired license to build the Viper 2½ years ago.

**• SNCA du Sud-Ouest will start deliveries of the production jet bomber version of the Vautour to the French Air Force in the spring of 1957. The production all-weather fighter will be delivered earlier.**

• The Napier Gazelle, 1260-hp shaft-drive version of the Oryx gas generator, may be selected to power the Bristol 193, latest of the 173/191 family of twin-engine, twin-rotor helicopters.

**• Italy's Piaggio company has designed a 9-12-passenger transport powered by a nose-mounted 3,200-ehp Armstrong-Siddeley. Double Mamba coupled turboprop. Designated P.153, it will have a cruising speed of 250 knots at 20,000 ft. Range will be 1,200 nautical miles.**

• France's Breguet company is likely to get into the electronics field following the acquisition of the Radio Industries concern by Sylvain Floirat, chairman of Breguet.

**• Latest version of the Bell X-1 series research aircraft is the X-1E, basically the original X-1 with a modified fuel system, new cockpit arrangement and a 4% wing-to-chord ratio. The X-1B, an earlier model, used the 8% thick wing of the basic X-1, but had a longer fuselage with higher fuel capacity for increased performance.**

• McDonnell Aircraft's F-101 supersonic interceptor and Republic's F-105 reportedly have numerous points of similarity. The F-105 however, is said to be considerably larger than the F-101.

**• Foreign airline orders for airborne weather radar are beginning to show. Sabena Belgian Airlines has ordered RCA-built C-Band radar for both its DC-7s and Convair 440s now on order. KLM is also understood to have ordered its DC-7Cs radar-equipped.**

• Lockheed's C-130A Hercules turboprop transport, which recently won an Air Force follow-on order in excess of $100 million, reportedly will carry three Nike missiles without launching gear. Production schedule for the C-130A at Lockheed Georgia Division now extends into 1958.

**• Air Force is considering an order for four or five Martin P6M SeaMasters. Army, in turn, is weighing a similar order for Hiller's "Flying Platform" which was developed under Office of Naval Research sponsorship but partially financed by Army funds.**

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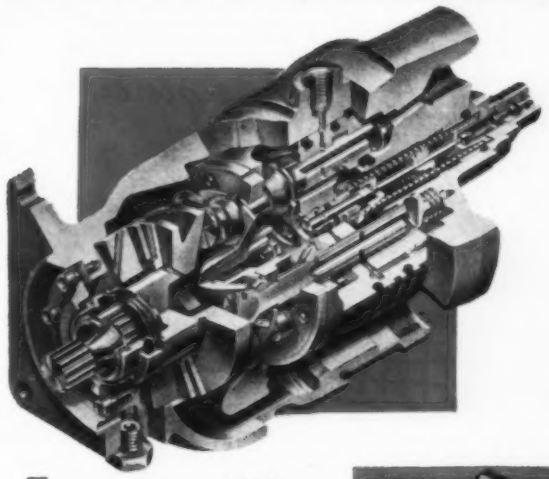

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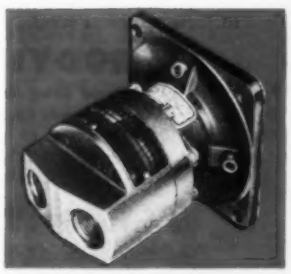

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### SERIES 67W
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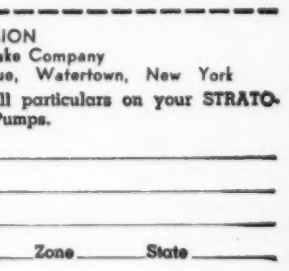

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**A DIVISION OF GENERAL DYNAMICS CORPORATION**
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# When & Where

**Oct.** 24-25—IRE professional group on Electron Devices, 1955 annual technical meeting, Shoreham Hotel, Washington, D. C.

**Oct.** 25-27—American Institute of Electrical Engineers conference on aircraft electrical applications, Los Angeles.

**Oct.** 26—University Aviation Association annual meeting, Cleveland.

**Oct.** 26-28—National Aeronautic Association annual meeting, Cleveland.

**Oct.** 26-28—Southeastern Airport Managers' Association annual meeting, Greenville, S. C.

**Oct.** 27-28—Aircraft Electrical Society 12th annual display of aircraft electrical equipment, Pan-Pacific Auditorium, Los Angeles.

**Oct.** 31-Nov. 1—East Coast Conference on Aeronautical and Navigational Electronics, sponsored by I.R.E., Baltimore, Md.

**Oct.** 31-Nov. 2—Soc. of Automotive Engineers transportation meeting, St. Louis.

**Oct.** 31-Nov. 3—At Ground Equipment and Maintenance Facilitation Subcommittee meeting, Hotel New Yorker, N. Y.

**Nov.** 1—International Civil Aviation Organization, Pacific regional air navigation meeting, Manila.

**Nov.** 1-3—Air Transport Association's Air Traffic Conference, San Francisco.

**Nov.** 1-3—Air Traffic Conference, Palace Hotel, San Francisco, Calif.

**Nov.** 2-3—Transport hydraulic conference, sponsored by Vickers, Inc., Detroit.

**Nov.** 3-4—TACAN symposium conducted by Air Navigation Development Board, Washington, D. C.

**Nov.** 3-4—Institute of Aeronautical Sciences and Canadian Aeronautical Institute, second annual joint meeting, Chateau Laurier, Ottawa, Ont., Canada.

**Nov.** 3-4—Joint meeting of the Institute of the Aeronautical Sciences and the Canadian Aeronautical Institute, Ontario.

**Nov.** 7-9—Eastern Joint Computer Conference (IRE-AIEE-ACM), Hotel Statler, Boston.

**Nov.** 8-9—National Air Taxi Conference, annual meeting, Hotel Westward Ho, Phoenix.

**Nov.** 8-10—National Aviation Trades Association annual convention, Phoenix, Ariz.

**Nov.** 9-11—Industrial Management Society, time, motion study, management clinics, Hotel Sherman, Chicago.

**Nov.** 13-18—American Rocket Society-American Society of Mechanical Engineers joint meeting, Chicago.

**Nov.** 14—American Society of Mechanical Engineers Aviation meeting, Conrad Hilton Hotel, Chicago.

**Nov.** 14-16—Aviation Distributors & Manufacturers Association 26th annual meeting, El Mirador Hotel, Palm Springs, Calif.

**Nov.** 21-22—Symposium on aeronautical communications sponsored by Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

**Nov.** 28-30—Instrumentation Conference and Exhibit, sponsored by I.R.E., Atlanta Biltmore Hotel, Atlanta, Georgia.

**Dec.** 2-3—Eighth annual aviation conference & flight clinic, Tucson, Ariz.

**Dec.** 6-7—Professional Race Pilots' Association annual convention & business meeting, Carter Hotel, Cleveland.

**Dec.** 12-16—Nuclear Engineering & Science Congress, sponsored by Engineers Joint Council, Public Auditorium, Cleveland.

### INTERNATIONAL

**Nov.** 1—ICAO Pacific regional air navigation meeting, Manila.

**Nov.** 3-4—Institute of the Aeronautical Sciences-Canadian Aeronautical Institute joint meeting, Ottawa.

**Nov.** 19—European Civil Aviation Conference, Strasbourg, France.

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*Called "Instant Response" because it starts, stops or reverses almost instantaneously.

Vickers Constant Displacement Piston Type Hydraulic Motors are available in 24 sizes for 3000 psi.

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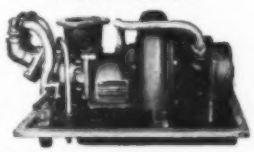
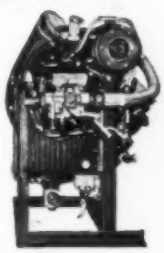


Fuel Transfer Pump built by Nash Engineering Co. for Boeing KC-97 Tanker. Powered by Vickers "Instant Response"* Hydraulic Motor.

### CABIN SUPERCHARGING

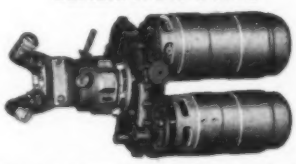
Douglas DC-7 Cabin Supercharger is driven by Vickers "Instant response"* Hydraulic Motor.



### HORIZONTAL STABILIZER ACTUATOR

Built for Grumman F9F6 by Cleveland Pneumatic Tool Co. Powered by Vickers "Instant Response"* Hydraulic Motor.

### ALTERNATOR GENERATOR DRIVE



Alternator Generator Drive for Convair T-29 uses Vickers "Instant Response"* Hydraulic Motor.

### TELESCOPING BOOM ACTUATOR

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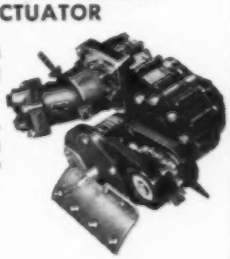

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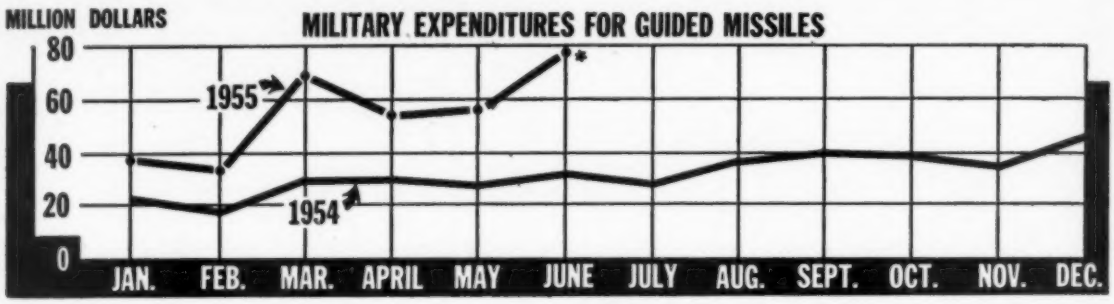
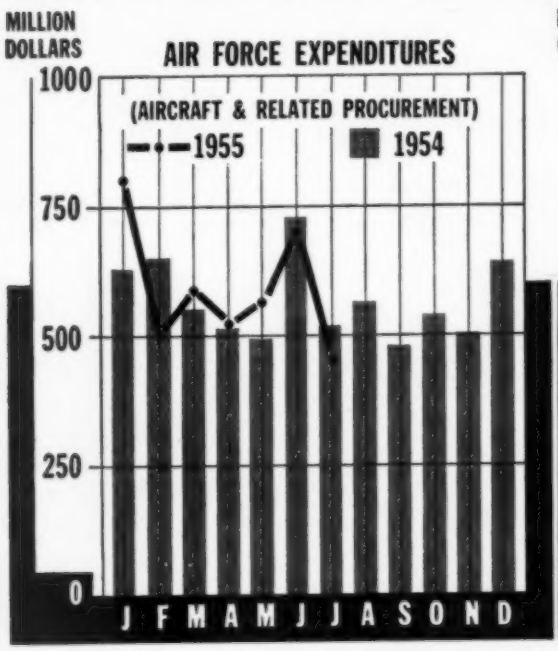
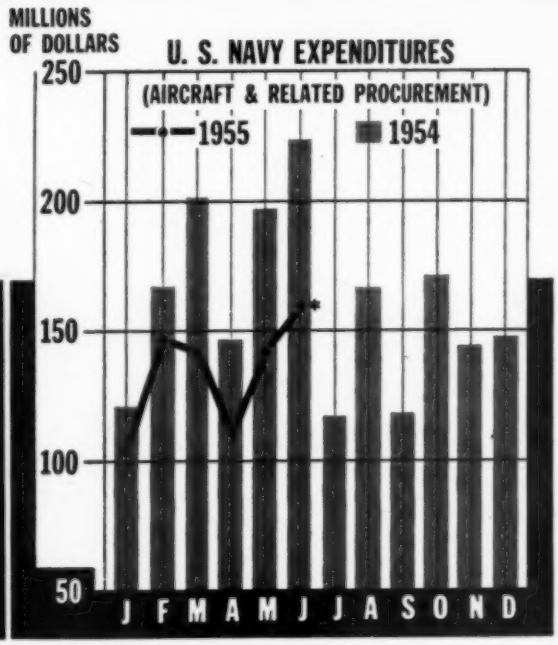
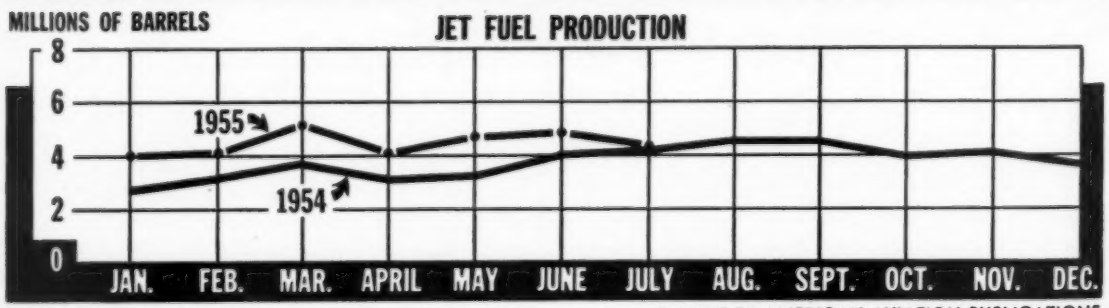
# Pulse of the Industry



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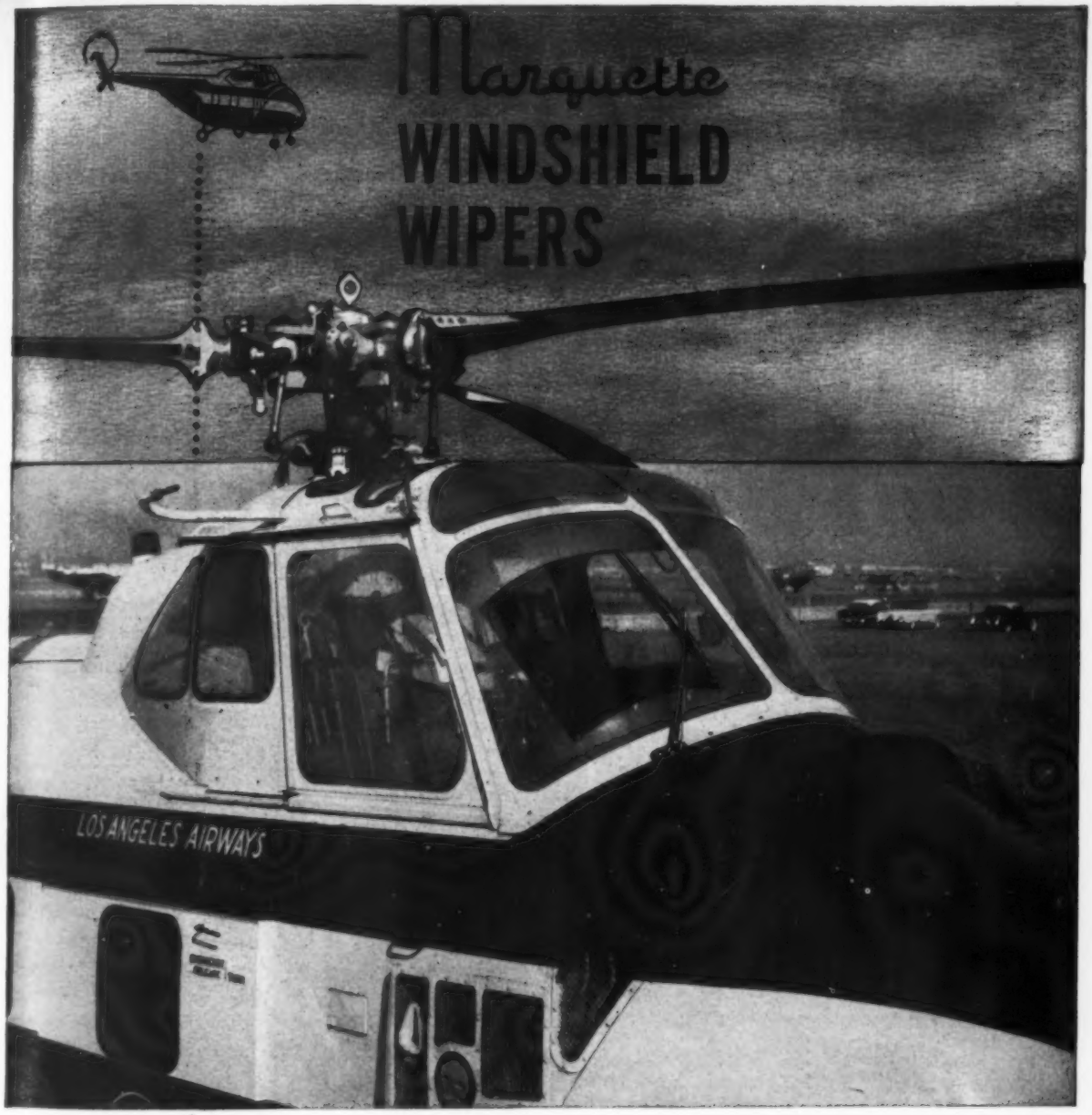
CHARTS BY AMERICAN AVIATION PUBLICATIONS

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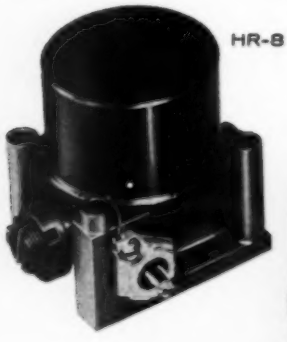

HR-8

HR-9

| SPECIFICATIONS | HR-8 | HR-9 |
|---|---|---|
| RATED FLOW: | 2.8 G.P.M. at 1500 P.S.I. Press. Drop and 8 MAΔI | 4 G.P.M. at 1500 P.S.I. Press. Drop at 8 MAΔI |
| GAIN: | .40 G.P.M. Per MAΔI | .5 G.P.M. Per MAΔI |
| OPERATING CURRENT: | 4 MA Quiescent | 4 MA Quiescent |
| OPERATING PRESSURE: | 1500 P.S.I. | 3000 P.S.I. |
| LEAKAGE: | .15 G.P.M. Max. (None External) | .15 G.P.M. Max. (None External) |
| NATURAL FREQUENCY: | 250 CPS | 250 CPS |
| DITHER: | None | None |
| COIL: | Concentric Double Wound. | Double Wound, Equal Resistance Windings |

HR-10

HR-11

| SPECIFICATIONS | HR-10 | HR-11 |
|---|---|---|
| RATED FLOW: | .4 G.P.M. at 3000 P.S.I. Press. Drop and 8 MAΔI | .4 G.P.M. at 3000 P.S.I. Press. Drop and 20 MAΔI |
| GAIN: | .05 G.P.M. Per MAΔI | .02 G.P.M. Per MAΔI |
| OPERATING CURRENT: | 4 MA Quiescent | 10 MA Quiescent |
| OPERATING PRESSURE: | 3000 P.S.I. | 3000 P.S.I. |
| LEAKAGE: | .10 G.P.M. Max. (None External) | .10 G.P.M. Max. (None External) |
| NATURAL FREQUENCY: | 160 CPS | 160 CPS |
| DITHER: | None | None |
| COIL: | Double Wound, Equal Resistance Windings | Double Wound, Equal Resistance Windings |

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# Personal View

By WAYNE W. PARRISH

## Low-Speed Flight Research - It Wasn't Forgotten, After All

IT would be surprising indeed if the recurring theme of this annual Research and Development Issue of AMERICAN AVIATION were something other than the intense drive for speed and power. Supersonic speeds, missiles and nuclear power have utmost priority in the impressive activity blanketed under the term Air Power.

But it is not without significance that two leading spokesmen represented by signed articles in this issue, one British and the other American, have laid stress on what might be called rear-guard action. In the headlong rush for speed and power, the takeoff and landing problem became lost in the shuffle. It can now be said that attention is being given to the almost-forgotten runway dilemna.

Dr. John Victory, executive secretary of the NACA, discusses research in low-speed flight. Obviously, he says, we cannot go on increasing airfield sizes. There must be a limit to runway lengths. So while a large segment of industry is busy pushing speed and power to ever-greater lengths, such low-speed projects as the helicopter, convertiplane, several forms of vertical takeoff, the thrust vector or "flying platform," thrust reversal for jets, improvements in seaplane hulls and improvements in the application of boundary layer controls, are now getting prime attention from others.

Not by coincidence, surely, but because it was inevitable that the problem had to be recognized sooner or later for what it is, Mr. James Hay Stevens, the distinguished London editor of this magazine, writes that "probably the key to or inspiration for European aeronautical thought today is the elimination of the runway." His comprehensive account of European projects and studies along this line is worthy of close reading.

We noted with particular interest Dr. Victory's inclusion of boundary layer control as a well-known means of reducing landing speeds. If our ears have picked up industry trends correctly, the recaptured interest in boundary layer control may hold much promise for the future. It is one means of reducing runway requirements without altering aircraft configurations radically. At least one major project currently in the wind could open up substantial new markets for both military and commerce.

We think it is a healthy indication of a vigorous industry that while the push for speed and power continues unabated, time and attention is now being devoted to utilizing the best capabilities of airlift in the smallest takeoff and landing area possible. Shore takeoffs and landings—or vertical takeoffs and landings if you prefer—can lead to an enormous new outlet for both commercial and military aircraft to take up the slack which will occur inevitably in due course when unmanned missiles replace some types of purely military aircraft.

The contents of this issue offer as many glimpses into the future and as many technical challenges as security precautions permit.

Last year's annual issue contained the most comprehensive review of missiles ever published before or since. This year the review is considerably broader in scope and again, we feel, it is the most comprehensive of its kind ever published.

This issue is, then an encyclopedic check-list of the enormous frontal approach to greater Air Power, ranging from the slowest to the fastest, the smallest to the biggest, combined with the highest and the farthest reach.

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of all the Chandler-Evans Pumps, Fuel Controls, and Accessories, send for your copy of the CECO Circular, "Engineered For The High And The Mighty . . ." or simply write outlining your fuel control problems. Our engineers will be glad to work with you to help build new standards of performance into your next design project.

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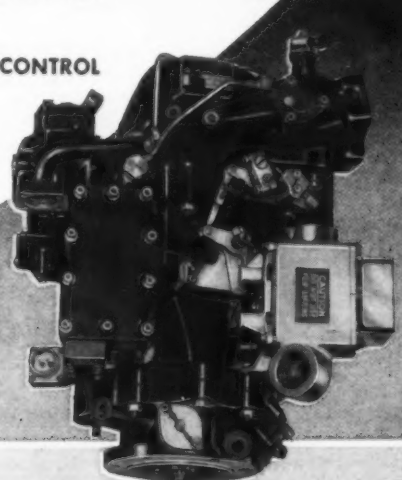
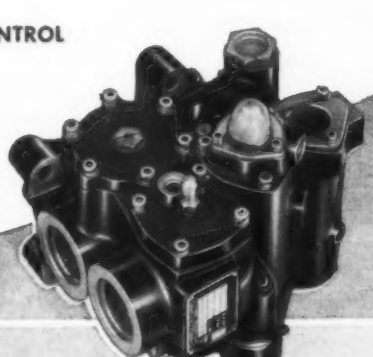
MAIN CONTROL



AFTERBURNER CONTROL



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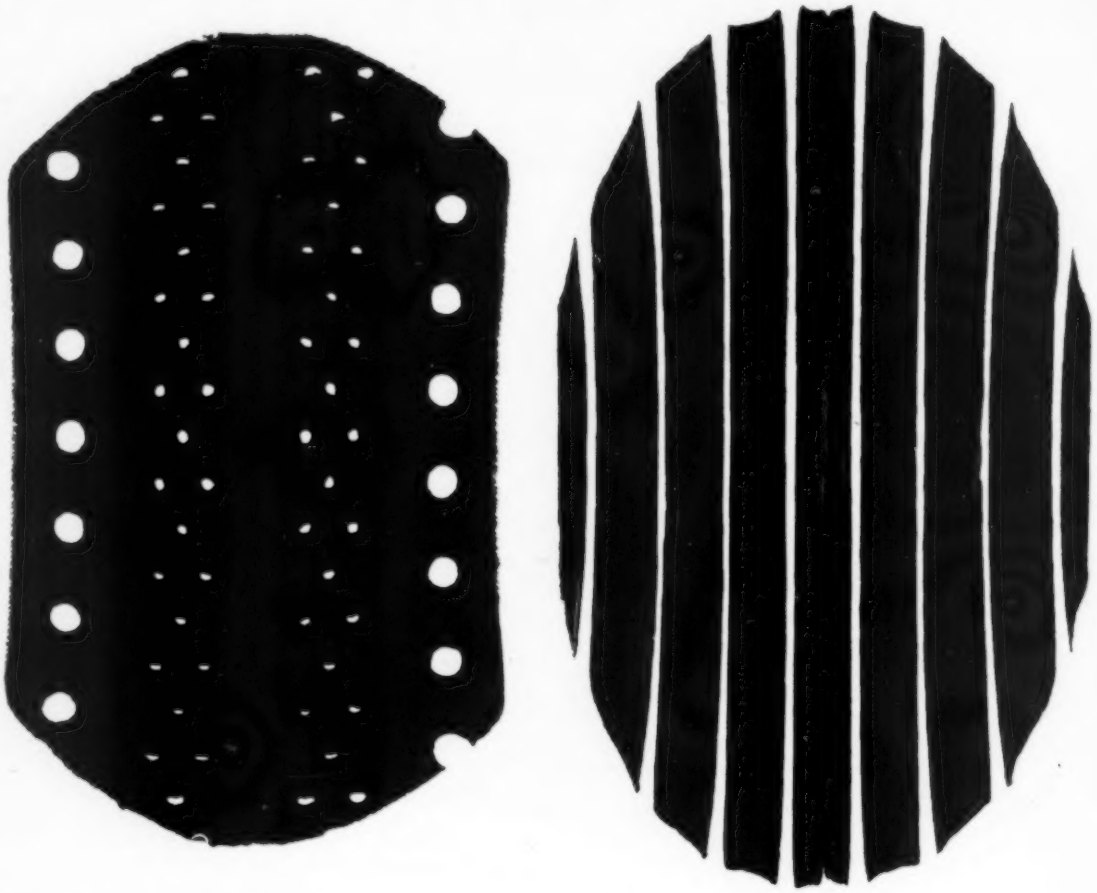
RESEARCH KEEPS **B.F.Goodrich** FIRST IN RUBBER



*Actual ¼-scale footprint of 12.50-16 tires inflated to 75 lbs. under 12,800 lb. load.*

# Which tread gives more landings . . . Dimpled or ribbed?

YOU CAN JUDGE a tire by its footprint. The B. F. Goodrich tread pattern on the left gives 10% more landings before recapping, on the average, than the ribbed design on the right!

Why? First, take a good look at the more compact, more rectangular footprint of the B. F. Goodrich Dimpled Tire. That's the result of an overall improvement: the tread profile of the Dimpled Tire is designed to put more tread rubber to work and to spread the load more evenly—shoulder to shoulder. Unlike the conventional ribbed tire which places most of the load on the center ribs, the shoulders of the BFG Dimpled Tire bear their fair share of the load.

Second, notice the most significant difference between the tread patterns—the use of cup-like indentations in the B. F. Goodrich Tire. This unique design further reduces wear because the tread rubber around each dimple is compressed under load—making it more stable and much more resistant to cuts and tears.

Like the first high-pressure Tubeless Tire and the first 300 mph Tubeless, the Dimpled Tire is another example of B. F. Goodrich leadership in research and engineering. Latest example: the first aviation Tubeless Tires in commercial service are Dimpled. *The B. F. Goodrich Company, Tire & Equipment Div., Aeronautical Sales, Akron, Ohio.*

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VOL. 19, NO. 11

# U.S. Air Weapons Development Must Be the Best -- Not Just 'Good Enough'

By TREVOR GARDNER

*Assistant Secretary of Air Force (Research and Development)*

Two basic military facts remain standing unassailable, despite much current talk about so-called easing of international tensions: First, it is folly to neglect the tools of war before we eliminate the threat of war; second, the best likelihood for continuing world peace is maintenance of a decisive air atomic striking force so that an aggressor will know beyond a shadow of a doubt that we can destroy him if he moves against us.

To achieve and maintain such qualitative superiority over any possible aggressor is the essence of our research and development program. The success of this program, as in any business, depends on an ability to produce a better product at a lower price than competitors. Determination of the extent of competition, existing or anticipated, is relatively simple in the business world. In the Air Force such determination is based on intelligence information which is extremely hard to get and is never completely reliable.

Therefore we cannot afford to gear the research and development program to intelligence information alone. We must completely exploit the technological potential of this nation to be sure we are getting the very best and not something that may be merely good enough. These considerations go to build the requirements of Air Force Research and Development.

The scope of the program is determined by a series of decisions which are at best a carefully considered compromise between requirements imposed by evaluation of military risk against the limitations of technology, industry, manpower and military budget.

Just pouring out more money for research and development does not assure success if the quantities and qualities of people are not available. Presently we are operating without over-extending the Nation's scientific capability, but unless the country begins to graduate many more engineers and scientists, we are going to be in serious trouble.

Budget considerations always force certain desired projects out of the research and development program. Determining what must be eliminated calls for the highest type of military and management decision, particularly in view of the fact that the practical limit of reduction has been reached.

It is an incredibly complex management job to get the right size and balance in the operation and to obtain the necessary military research and development within a peacetime environment.

The virtually non-existent military research and development program of the post World War I years became a highly effective operation under the compulsions of World War II.

But such surges of activity are wasteful and could prove disastrous. Sound research and development programs are identified with long-range objectives and necessary continuity of support of the resources to carry it out.

The Air Force has seen what can happen with fluctuating budgets and hot-and-cold interest and appreciation of stable programs. For example, the Korean War caused a great increase in the research and development budget and other support. The maintenance of a strong, healthy program during the years between World War II and Korea would have given our forces better equipment sooner and made the crash projects largely unnecessary.

It is apparent that the Air Force must maintain a research and development program that is sufficiently large and diversified to meet the weapons systems demands of all assigned military tasks.

Some of these requirements are experiments with nuclear propulsion to meet the need for intercontinental aircraft, better performance in jet engines to enable planes to fly higher and faster, better materials to overcome heat problems posed by very high speed aircraft and development of rocket engines.

We in the Air Force are not complacent about the progress we are making in these and other critical areas of effort to maintain weapons superiority. We will continue to maintain a sense of urgency in approaching these problems so that the new developments will become available to our forces in the shortest possible time. ◈◈◈

# U. S. Turning from Manned to Unmanned Weapons

**Biggest problem for industry: who will build them? Airframe builders wage stiff fight for share of business.**

By ROBERT M. LOEBELSON

MILITARY research and development activities this year are moving in many directions. But with the exception of the atomic-powered aircraft project, the highest priorities in the R&D field are on guided missiles, especially those which can be launched from the U.S. and hit a target up to 5,000 miles away.

It is almost inevitable that missiles should account for so much of the research effort in this country. For at the speeds and altitudes at which today's (and tomorrow's) aircraft and missiles fly, it is virtually impossible to be certain that a man-carrying aircraft will be able successfully to intercept them and knock them out of the sky before they blast their target into oblivion with a nuclear weapon.

As the importance of man-carrying aircraft declines (medical studies show that human endurance is the limiting factor on speeds and altitudes), the aircraft industry is looking to pilotless aircraft to account for most of the production for the military services.

• **Trevor Gardner,** Assistant Air Force Secretary for R&D, recently pointed out that it is only natural for aircraft firms to produce missiles. He cited the fact that missile propulsion systems are merely advanced aircraft engines of the turbojet, ramjet or rocket variety. Moreover, he added, aerodynamic and flight control problems and their solutions are the same and navigation and bombing problems are resolved by the same principles and frequently by the same equipment.

Despite Gardner's statement, there are some indications that aircraft companies may end up with a role secondary to that of electronics firms.

Corporate names like Sperry-Rand, Raytheon, Western Electric, Hughes, Chrysler, Eastman Kodak, General Electric, Westinghouse, Philco, Bendix, Sylvania, RCA are now just as common in the guided missile business (and in some cases more so) than such old-line aircraft firms as Douglas, Boeing, Convair, Northrop, Bell, North American and Martin.

To meet the threat, the prime aviation companies have jumped into the electronics field to such an extent that it is sometimes difficult to determine whether some airframe builders should not now be classified as electronics outfits. In one sense, there is considerable logic in assigning a complete missile weapons system to an electronics firm because it is those "little black boxes" and instruments which will guide the weapon to its target.

• **On the other hand,** it is usually the aircraft company which handles the final assembly of a missile and so there is also some logic in assigning overall responsibility to the airframe firm. To try to prevent encroachment on what it considers its own domain by electronics companies, the aircraft industry has begun to hire hundreds of electronics engineers and in many cases to set up the equivalent of electronics subsidiaries.

The military services are apparently confused about how to assign responsibility for missiles development. Examples:

• In the case of the Army's surface-to-air Nike, Western Electric Co. holds the prime contract but Douglas, as a subcontractor, assembles and delivers the missile.

• As far as the Navy's air-to-air Sparrow is concerned, there are three different models, handled by Sperry-Rand, Douglas and Raytheon. But on the Navy surface-to-air Talos, Bendix is the prime contractor, while McDonnell handles the development of the ramjet engines and RCA the guidance system.

• The Air Force's air-to-surface Rascal, on the other hand, is handled by Bell Aircraft as a complete project, with Bell also developing the liquid propellant rocket engine and the guidance system as well. But another AF missile, the Atlas intercontinental ballistic weapon, has been assigned to Los Angeles' Ramo-Wooldridge Corp. for overall direction after long being a Convair project.

Despite the fact that guided missiles have been an integral part of military planning ever since the Germans launched their V-1s and V-2s during the latter part of World War II more than a decade ago, it is significant that in 1955 only a handful of U.S. missiles are in what could be called production. The majority of the more than a score of 'birds' being financed by the three military services are still in the R&D stage.

Nevertheless, the sums allocated for production and procurement of missiles have risen steadily, showing minor drops for fiscal 1954 and 1955. The following table shows the new money appropriated by Congress for the past seven years for purchase of missiles but does not include additional funds for missile R&D activities.

### AF and Navy Budgets for Research & Development

(1954, 1955 and 1956)

The importance of guided missiles is probably best pointed up by the sums of money used by the Air Force and Navy for research and development, especially when a comparison is made with R&D activities in the aircraft and related procurement field.

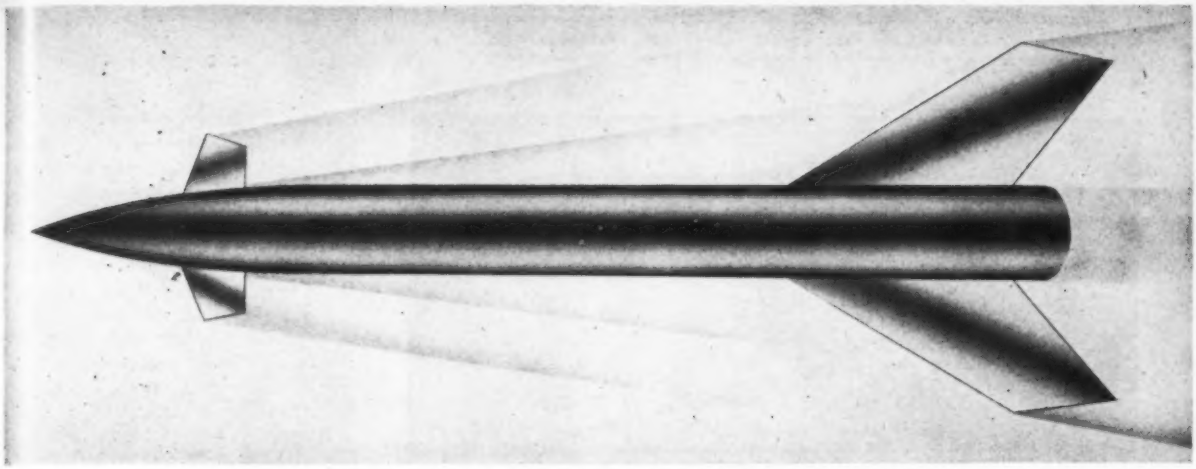
In the case of the Air Force, this is the comparison of obligations for the past three years (by budget program):

| | 1954 actual | 1955 estimate | 1956 estimate |
|---|---|---|---|
| Aircraft & Related Proc. | $126,272,600 | $114,898,500 | $133,967,000 |
| Missiles & Related Equip. | 93,475,154 | 120,262,000 | 102,008,000 |

As for the Navy, aircraft and missile research programs compare this way (by budget program):

| | 1954 actual | 1955 estimate | 1956 estimate |
|---|---|---|---|
| Aircraft & Related Proc. | $123,121,775 | $112,077,000 | $108,466,000 |
| Missiles & Related Equip. | 66,582,392 | 61,737,400 | 61,811,000 |

It appears therefore that over the past three years, the Air Force has obligated (or planned to obligate) 84 cents for missile research for every dollar allocated for studies of aircraft. The Navy, meanwhile, put 55 cents into missile development for every dollar spent for airplane research.



AIR-TO-SURFACE missile in this artist's version is believed similar to Bell's GAM-63 Rascal.

### Congressional Appropriations for Missiles

(Millions of Dollars)

| Fiscal Year | Army | Navy | USAF | Defense |
|---|---|---|---|---|
| 1950 | $0 | $17 | $9 | $26 |
| 1951 | 173 | 130 | 121 | 424 |
| 1952 | 253 | 119 | 95 | 467 |
| 1953 | 301 | 181 | 414 | 896 |
| 1954 | 225 | 159 | 364 | 748 |
| 1955 | 0 | 136 | 265 | 401 |
| 1956 | 0 | 238 | 700 | 938 |

In the past seven years, therefore, Congress has granted $3.9 billion to buy missiles and indications now are that for fiscal 1957 and later the annual appropriation will exceed $1 billion.

Spending and obligations have pretty much followed the pattern of Congressionally-appropriated money, with the usual lag of a couple of years between the time the orders are placed and the time the hardware is delivered.

### Missile Spending

(Millions of Dollars)

| Fiscal Year | Army | Navy | USAF | Defense |
|---|---|---|---|---|
| 1951 | $0.4 | $5.1 | $15.6 | $21.0 |
| 1952 | 46.4 | 56.1 | 66.2 | 168.9 |
| 1953 | 119.1 | 94.8 | 81.2 | 295.0 |
| 1954 | 186.6 | 141.1 | 175.9 | 503.5 |
| 1955 (11 mos.) | 66.5 | 158.0 | 264.5 | 489.1 |
| 1956 (est.) | 225.0 | 200.0 | 272.0 | 697.0 |

New orders placed with the aircraft and electronics industries for missiles have also risen steadily over the past few years.

### Missile Obligations

(Millions of Dollars)

| Fiscal Year | Army | Navy | USAF | Defense |
|---|---|---|---|---|
| 1951 | $34.6 | $119.1 | $121.3 | $275.0 |
| 1952 | 190.7 | 141.3 | 68.4 | 400.4 |
| 1953 | 121.9 | 154.1 | 228.6 | 504.6 |
| 1954 | 317.3 | 139.4 | 177.8 | 634.5 |
| 1955 (11 mos.) | 342.4 | 111.5 | 431.1 | 885.0 |

These are the missiles now in production:

• **Convair's Terrier** is a Navy surface-to-air missile with a range of about 10 miles and a speed of about Mach 2 at 60,000 feet. Aerojet produces the solid propellant rocket engine. Terrier was developed by Allegheny Ballistic Laboratories and Johns Hopkins and will be used not only for defense of Navy ships but also protection of Marine Corps ground bases.

• **Firestone's Corporal** for Army Ordnance. This is an outgrowth of the WAC-Corporal research project and is roughly comparable to the German V-2. It was developed by the California Institute of Technology and Douglas Aircraft and follows a ballistic trajectory over its range of about 150 miles. Liquid rocket engines produced by Ryan Aeronautical power the surface-to-surface Corporal.

• **Western Electric's** Nike 1 for the Army. As a surface-to-air weapon, it replaces certain types of anti-aircraft artillery and is now being installed around most of the nation's major cities. Nike has come under critical attack from several quarters because of its limited range (20-25 miles and a larger Nike B, capable of reaching 70,000 feet and hitting an attacking aircraft 50 miles away, is being evolved. Propellant is an Aerojet liquid fuel rocket engine.

• **Douglas Honest John** for the Army. This is an unguided 762-mm artillery rocket fired from a mobile launcher and has a range of 15-20 miles. It is in the short-range surface-to-surface category. Propellant is a Hercules Powder Co. solid propellant rocket.

• **Chance Vought's Regulus** for the Navy. This ship-to-surface missile has a range estimated at 300 miles and is powered by a short-life Allison J33 turbojet. It will eventually be fired also from the Nautilus atomic submarine.

• **Martin's TM-61 Matador** for the USAF. This surface-to-surface "bird" has a range of between 500 and 600 miles and is powered by a J33 similar to that in the Regulus. The Air Force has just established its fourth Matador-equipped tactical missile squadron, of which two are already on duty in Germany. Matador is fired from a mobile launcher.

• **Sperry's Sparrow I** air-to-air missile for the Navy. This model has a range of about five miles and uses an Aerojet solid fuel rocket engine for power. It will also be produced in slightly different versions by Douglas and Sperry.

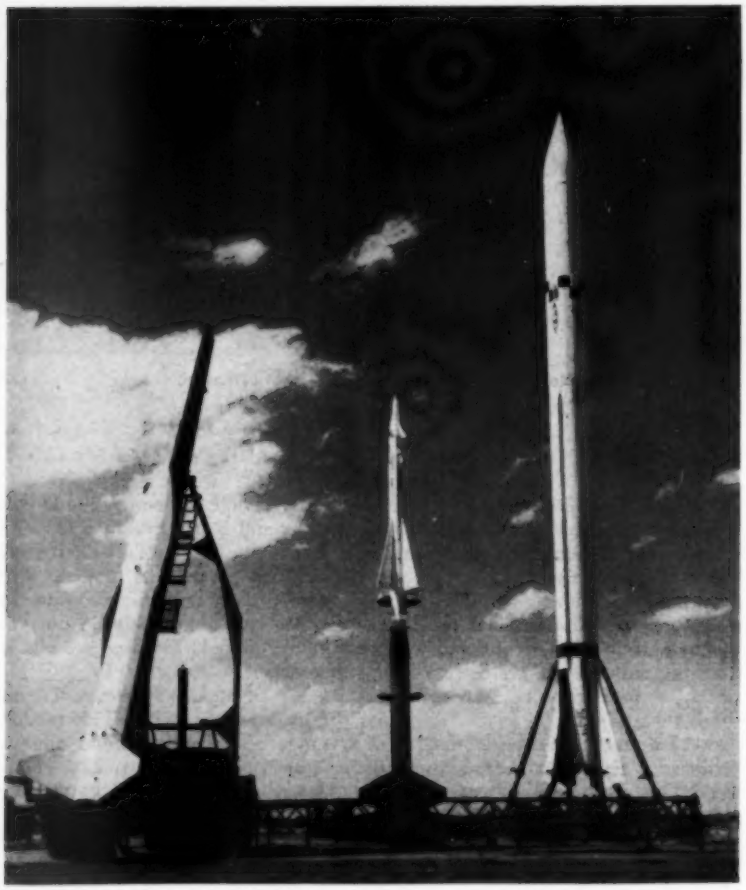
• **Hughes' GAR-1 Falcon** air-to-air missile for the USAF. Propellant is a Thiokol Chemical Co. sold fuel rocket and range is four miles. Falcon will be carried by the Convair F-102, Northrop F-89H and several other new USAF interceptors. Philco Corp. has been designated a second-source producer.

The missiles still in the research and development cycle include:

• **Martin's Lacrosse** surface-to-surface vehicle being produced for the Army and the Marine Corps. Designed for close support of ground troops, Lacrosse was developed by Cornell Aeronautical Laboratory, has an eight-mile range.

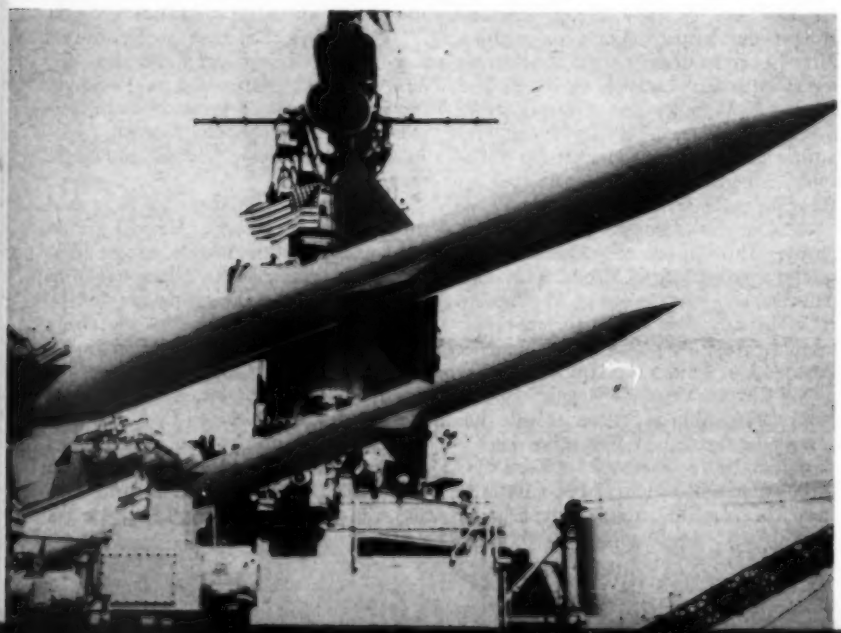
• **Martin's Bulldog** air-to-ground missile for the Navy. Very little is known about this missile except that the name was recently changed from Bullpup, probably indicating growth.

• **Chrysler's Redstone** for the Army uses a North American Aviation liquid rocket engine to propel it to a target less than 200 miles away. Larger than the V-2, it was developed by "liberated" German scientists and American experts at the Army's Redstone Arsenal in Huntsville, Ala. It too is a ballistic missile and test models are being turned



ARMY'S PRODUCTION MISSILES include the Honest John, Nike and Corporal.

CONVAIR'S TERRIER will be ship-launched by the Navy and ground-launched by the Marines



out at the Navy-owned plant built for Chrysler to produce J48 turbojet engines.

• **Northrop's Snark** for the AF is the first intercontinental surface-to-surface missile to reach the flight test stage. With a design range of 5000 miles the SM-62 Snark has used Westinghouse J40s, Allison J71s, and Pratt & Whitney J57s as power plants. It is a transonic vehicle reaching altitudes of 60,000 feet.

• **North American's SM-64 Navaho** is another USAF intercontinental missile using Curtiss-Wright ramjets and NAA liquid rocket engines for propulsion. It travels at Mach 2.5 at altitudes of 75,000 feet.

• **Convair's SM-65 Atlas** is the AF "absolute weapon," an intercontinental ballistic missile capable of hitting a target 5,000 miles away after reaching up to Mach 15 at its maximum acceleration. Altitude reached by the multi-stage 15-ton Atlas is between 600 and 800 miles. NAA produces the very high-thrust rocket engines which will propel Atlas on the first stage.

• **Bell's GAM-63 Rascal** for the AF is an air-to-ground missile with a range of about 100 miles which is radio-controlled to its target from the mother plane. Traveling at Mach 2, Rascal uses a Bell liquid fuel rocket engine. It will be launched by the B-47 and other medium and long-range bombers. Other GAM's with ranges up to 1,000 miles are under development.

• **Eastman Kodak's** air-to-surface (and air-to-underwater) **Dove** for the Navy probably uses a rocket engine for propulsion. Virtually no details have been released.

• **Fairchild's air-to-underwater Petrel** for the Navy uses a Fairchild J44 turbojet for power but little other data has been revealed.

• **Philco's air-to-air Sidewinder** for the Navy will serve in the same way as the Sparrow and the AF's Falcon. Again not too much is known except that Sidewinder will probably use three solid fuel rockets.

• **Bendix's Talos** surface-to-air ship-board-launched missile for the Navy is powered by McDonnell ramjets. Several versions are being developed including a longer-range model (the Talos-L) which may be ordered by the USAF as well. It was developed by the Johns Hopkins Applied Physics Laboratory.

• **Boeing's IM-69 Bomarc** for the AF is a Mach 2.5 surface-to-air missile with a range of more than 200 miles. Aerojet produces the solid fuel rocket and Marquardt the two ramjets which propel Bomarc (formerly called F-99 and then IM-99). When this missile is

DIOPLANE'S Q-1B TARGET drone is the forerun- of the USAF GAM-67.

SPARROW AIR-TO-AIR MISSILE is produced by three companies for Navy aircraft.

CHANCE VOUGHT REGULUS missile is fired from both surface vessels and submarines.

FIRST OPERATIONAL AF MISSILE is the Martin TM-61

L NEW USAF interceptors will fire the ghes GAR-1 air-to-air missile.

STILL UNDER USAF development, the Boeing Bomarc will probably be built at a Mid-west site.

NAVY
XP6M-1

# takeoff to tomorrow

This is the SeaMaster story—foreword to a new chapter in the epic history of Naval aviation.

Now being readied for its role as the U.S. Navy's first multi-jet attack seaplane, the primary mission of the big swept-wing Martin XP6M will be mine laying and photo-reconnaissance. And it promises to be of major military importance.

For the SeaMaster is the first of a new aircraft *type*. And as the spearhead of a whole new arm of the naval arsenal—the Seaplane Striking Force—it now focuses attention upon a revolutionary principle of military strategy known as the waterbased aircraft concept. Here's why:

The SeaMaster has global range. Powered in the over-600 *mph* class, it can operate from the seaways, lakes and rivers of the world, on extended periods of duty, and independent of fixed bases. For the Martin development program includes facilities for off-shore maintenance, refueling and resupply which provide a flexibility and mobility never before possible in military aircraft.

**MARTIN**
BALTIMORE

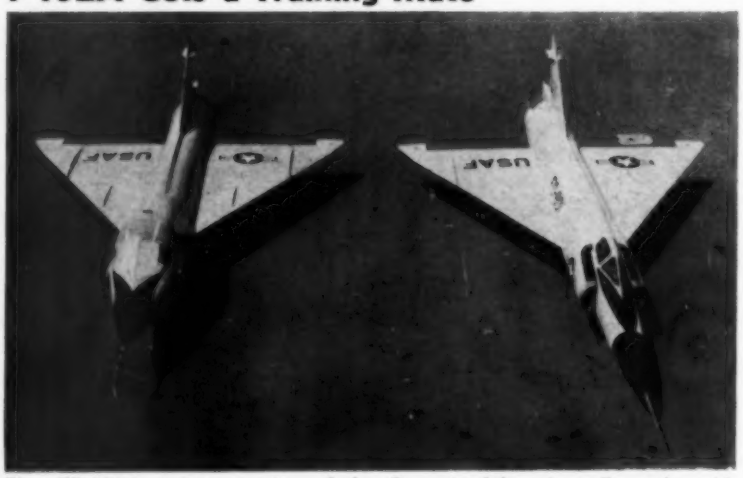
ready for production, it will probably be produced at an inland plant site rather than at Seattle.

• **East Coast Aeronautics' Loki** is an unguided surface-to-air Army missile based on the wartime German Taifun. Grand Central Aircraft produces the solid propellant rocket and Bendix has the contract for the launcher and the fuzes that are used with Loki. It is fired in salvos like anti-aircraft artillery.

• **Raytheon's Hawk** is a surface-to-air low-altitude Army missile designed to supplement Nike. Few details are known.

• **Radioplane's GAM-67** is a USAF project based on the company's Q-1B target drone.

## F-102A Gets a Training Mate




**First TF-102A, trainer version of the Convair delta-wing all-weather Air Force jet interceptor, has rolled out at San Diego. Flight tests begin this month at Edwards AFB. TF-102A is a side-by-side trainer that could be used as a fully tactical interceptor. It is equipped with dual basic instrument panels so it can be controlled from either position. Both the trainer and the interceptor versions of the supersonic F-102A use the Pratt & Whitney J57 with afterburner. TF-102A is at left in top picture with a standard F-102A; lower photo shows cockpit canopy design.**

• **Lazy Dog** is an antipersonnel missile developed by the USAF at Eglin AFB, Fla. Only a few inches long, it will be used from low-flying planes against troop concentrations.

• **Corvus** is a missile about which no information has been revealed.

While all of these missiles, both those in development and those in production and service, have high priorities, the government's greatest effort is being directed toward the development of the ICBM. Although development of the Atlas is considered a top-drawer project by the National Security Council (because of the possibility that the Russians might evolve their own ICBM first and thus truly negotiate from strength), there is still nothing resembling the wartime Manhattan (atomic bomb) Project as far as the U.S. ICBM is concerned.

Nevertheless, a highly significant contract is currently being considered by USAF planners—the award of an ICBM research and development project to another aircraft company.

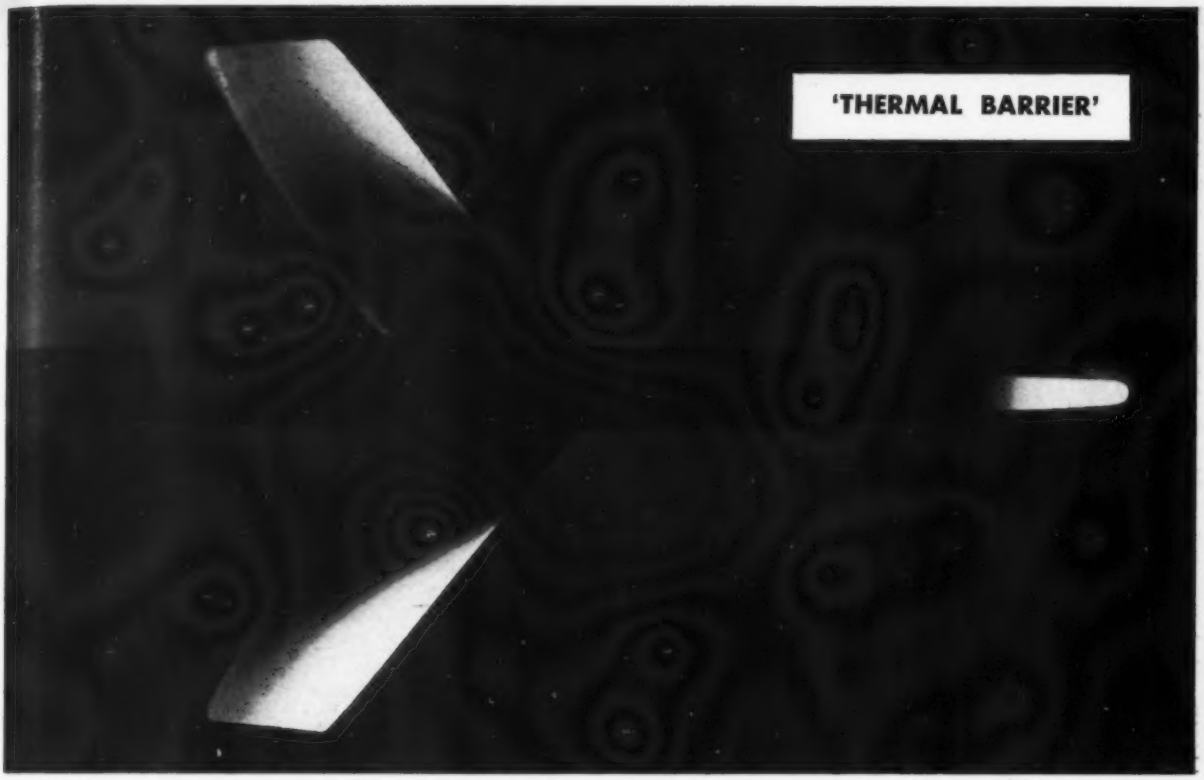
Despite the added cost (which will probably run into millions of dollars), the AF is reported on the verge of placing such a contract as "insurance" in case Atlas does not meet its development schedule or cannot perform its planned mission successfully. The field reportedly has been narrowed down to two airframe companies, one located on each coast. Four firms submitted entries in the original competition.

Like the Atlas, the second ICBM is expected to be rocket-powered and have a range of 5,000 miles. However, if the contract is awarded, the winning company will not have to start development from scratch. All the Atlas data will be made available to the firm authorized to build the Atlas competitor so that mistakes will not have to be repeated.

Missiles obviously are the coming hope for the aircraft industry. And until military purchases of pilotless aircraft equal or exceed those of manned fighters, bombers, cargo planes and transports, the emphasis will continue to be on missile R&D.

When the day comes that the research has paid off and missiles become reliable weapons which can reach their targets with a high degree of accuracy, the aircraft industry will probably find itself selling as much in the way of unmanned vehicles (dollarwise) as in aircraft.

But the threat of the electronics industry remains and aircraft firms will have to continue to build up their electronic facilities and personnel if they are to stay profitable. In any case, the past decade of missile development is only the prelude to the missile era of the 1960s. ◆ ◆ ◆




THE NEXT FRONTIER: HEAT. Infrared photo of NACA laboratory experiment simulating aerodynamic heating on model placed in jet of hot gas shows how sharp nose and thin wing leading edges heat up more rapidly than thicker parts. At sustained speeds of 7,000 mph, temperatures up to 8,000°F may be encountered.

*'Area Rule' Answers One Question As . . . .*

# NACA Probes Secrets of High-Speed, Low-Speed Flight

By DR. JOHN F. VICTORY

*Executive Secretary, National Advisory Committee for Aeronautics*

*"Although an aeroplane is designed so that statically it is stable to a satisfactory degree it does not necessarily follow that the machine is dynamically stable . . . ."*

Research in the area of dynamic stability is large in the science of aeronautics today, but note that the above comes from the first annual report of the National Advisory Committee for Aeronautics, written 40 years ago. What has happened in the past four decades? The radical advance of speed from less than 100 mph in 1915 to the 1,650 mph record of today has changed the numbers associated with the old problems and introduced new and complex problems at transonic and supersonic speeds.

There has been much progress, notably in the past eight years. Supersonic airplanes are now in regular military service. Research aircraft have flown at speeds beyond Mach 2 and have climbed above 90,000 feet. Turbojet engines have been so greatly improved that we are able to begin development of commercial jet transports.

• **One of the chief reasons** for rapid progress in recent years has been the NACA effort in the field of aeronautical research. The NACA is a research organization of more than 7,500 employees. In scientific and educational institutions and in industry there are thousands more engaged in aeronautical research and development.

One of the most interesting of the recent advances in aeronautics, released September 12, 1955, is the so-called "area rule" of NACA. Many qualified observers see in this singular concept the advent of a new era in aviation because the area rule is, in fact, a key to practical supersonic flight.

Whereas flight faster than the speed of sound has been recorded repeatedly since 1947, it always has in level flight been accomplished by the use of enormous, costly power of afterburners or rocket engines, otherwise when the airplane was diving. Even so, these flights were limited to a few minutes' duration at or above Mach 1.

With the use of the area rule in original design, the transonic airplane becomes a practical economic possibility. This is evident in the Navy's Grumman F11F-1 and the Air Force Convair F-102A. In these two planes (and more are coming) application of the area rule added handsomely to the top speed without any significant increase in power or weight of structure. *The F-102A gained 150 mph over its predecessor model.* That speed gain gave this hitherto subsonic airplane supersonic performance and saved for the Air Force a multi-million dollar airplane procurement program.

• **The area rule** is a simple rational way to reduce the large wing drag at transonic speed. The area rule offers three prime advantages: First, it per-

mits supersonic speed with significantly less power than formerly was required; second, it permits a useful range at supersonic speed; third, it permits rapid, smooth and economical acceleration through the transonic speed range. Finally, it permits supersonic speed in planes which otherwise would be limited to subsonic speed.

This discovery by Richard T. Whitcomb, 34-year-old aeronautical research scientist of the NACA Langley Aeronautical Laboratory, is one of the first fruits of the new transonic wind tunnels, of which the NACA now has several. These tunnels simulate free air conditions in the laboratory. It is pertinent to mention that another Langley research scientist, John Stack, won the 1951 Collier Trophy for concept and design of the transonic wind tunnel slotted throat, which makes possible useful transonic investigations in wind tunnels.

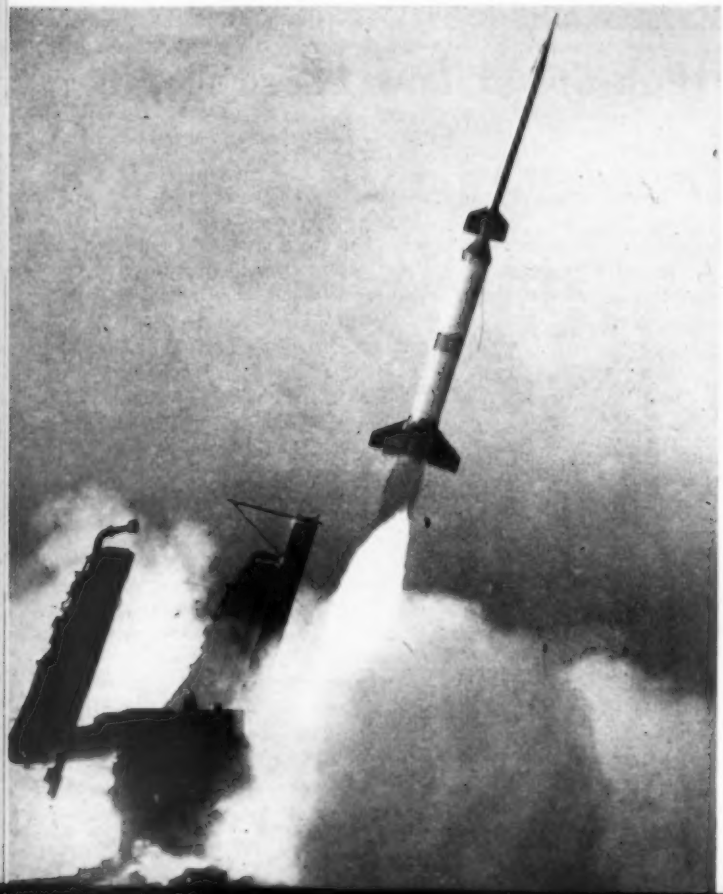
A whole family of new wind tunnels, authorized under the Unitary Wind Tunnel Plan Act of 1949, are coming into use now for development testing for industry of aircraft and engines of this age of high speed. They will permit laboratory investigations under large-scale conditions at speeds ranging from Mach 0.7 to 5.0.

• **Somewhat more forward-looking** are the researches in aerodynamic heating. An example of this effort is the Bell X-2, built to probe the so-called "thermal barrier," about which we have much to learn. With much stainless steel in its structure, with windshield glass tempered to withstand temperatures as high as 1000°F, and with a heavily insulated cockpit, this rocket-powered plane will provide new knowledge of aerodynamic heating.

The future holds secrets in another area of research, that of atomic energy for aircraft propulsion. Security prevents full discussion of this subject, but it is manifest that the application of nuclear power to the airplane is getting nearer. Design studies are being made by several manufacturers. In ad-

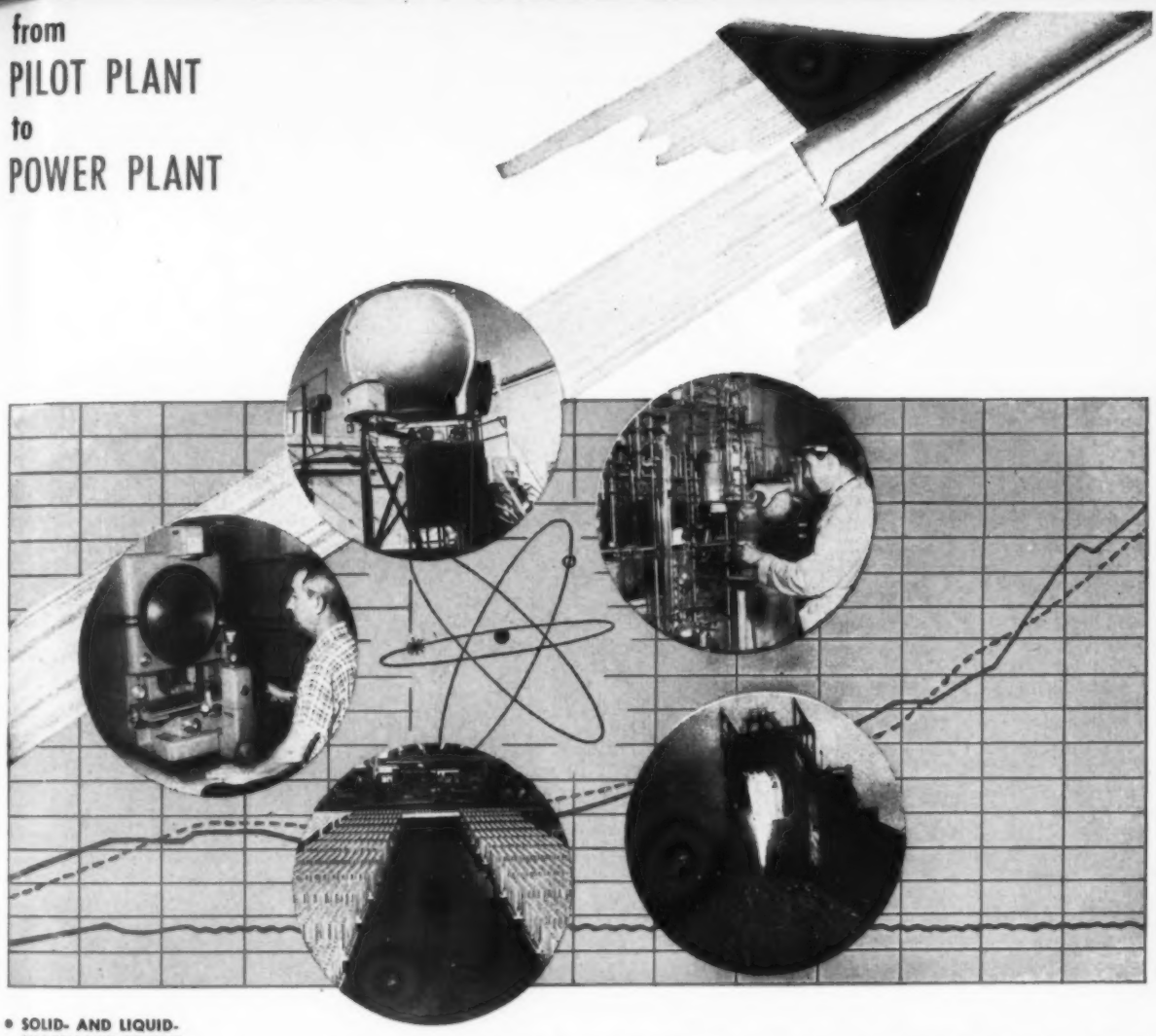
VOODOO TESTS. NACA's Ames laboratory prepares model of McDonnell F-101 for performance tests in 6-by-6-foot supersonic wind tunnel.

AERODYNAMIC HEATING is studied with cone-cylinder body (below) travelling at speeds up to Mach 5.6.



MULTI-ROCKET boosters get feasibility check in model launching below.

from
PILOT PLANT
to
POWER PLANT



- SOLID- AND LIQUID-PROPELLANT ROCKET POWERPLANTS FOR MISSILE AND AIRCRAFT APPLICATIONS
- AEROBRAKE THRUST REVERSER (SNECMA)
- AUXILIARY POWER UNITS AND GAS GENERATORS
- ELECTRONICS AND GUIDANCE
- ORDNANCE ROCKETS
- EXPLOSIVE ORDNANCE AND WARHEADS
- UNDERWATER PROPULSION DEVICES
- ARCHITECT-ENGINEER SERVICES FOR TEST FACILITIES

## QUALITY CONTROL FOR ROCKET ENGINE RELIABILITY

Today, as never before, rocket power is a dominant military requirement. Aerojet-General propulsion devices are used from Pole to Equator. They must operate with the flick of a switch at any altitude, any attitude, over extreme temperature ranges.

But the price of optimum reliability is maximum vigilance. At Aerojet, this means the uncompromising control of every characteristic of every engine, every component in research, development and production.

There are no short cuts to certainty. Aerojet uses all the techniques of modern quality programs — new-design control, acceptance sampling plans, statistical analysis, quality auditing. In actual test-firings of complete rocket systems, Aerojet has spent over six million man-hours since 1942.

The results are unique in the rocket propulsion field: *Aerojet products in field use have an overall measured reliability of 99.6%.*

**AEROJET-GENERAL NEEDS: Chemical Engineers • Chemists • Electronic Engineers • Mechanical Engineers • Physicists and Aeronautical Engineers**

Aerojet-General CORPORATION

A Subsidiary of The General Tire & Rubber Company

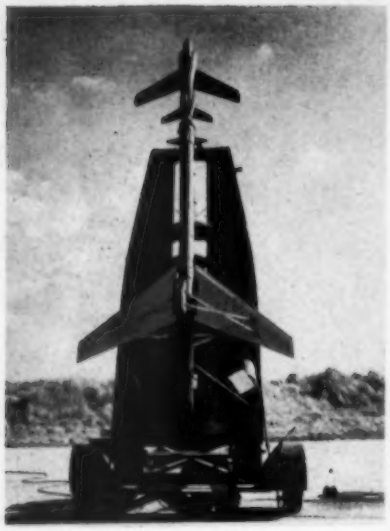
THE GENERAL TIRE

AZUSA, CALIFORNIA
SACRAMENTO, CALIFORNIA

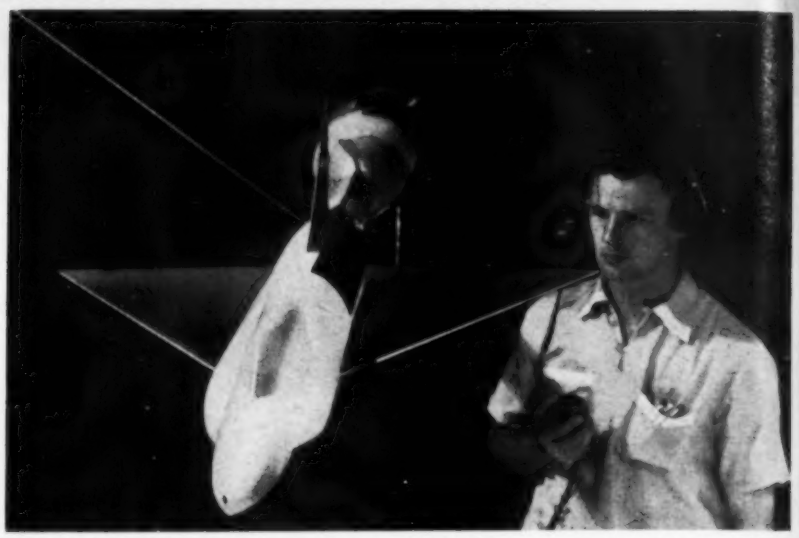
MORE POWER FOR AIR POWER



Circle No. 13 on Reader Service Card.



ROCKET-PROPELLED NACA model of Grumman F11F-1 Tiger ready for launching at Wallops Island.



OSCILLATING MODELS such as Convair F-102 fighter above are used at NACA's Ames Aeronautical Laboratory for wind tunnel dynamic stability tests.

dition, the NACA is about to build a research reactor near Sandusky, Ohio, for scientific study of components for a nuclear propulsion system.

In all our talk of speed and power we are apt to lose sight of another research area of no less importance, that of low-speed flight. Landing problems are still with us, since all aircraft literally must come down to earth. We can and must build them for high flight, but they must also have stability and control to take off and land safely at low speeds.

A corollary problem of growing magnitude to civil and military aviation alike is that higher landing speeds demand longer runways. Obviously we cannot go on increasing airfield sizes and there is a mounting demand to standardize on some limit for runway length.

This is why we must continue research on the landing speed problem. Lumped together, these proposals include the helicopter, convertiplane, the several forms of vertical takeoff, the

FLIGHT CHARACTERISTICS of Douglas X-3 are checked at transonic and supersonic speeds using rocket-propelled model.

GENERAL RESEARCH VEHICLE supplies jet vane data at NACA's Langley laboratory.

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ORENDA -a great Canadian engineering and development achievement

June 2, 1955 American Aviation DAILY Page 240

ORENDA ENGINE PROGRESS REPORTED TO AWA

**FOR TODAY**

Toronto, Canada (Special)--The Orenda-powered Canadian-built Sabrejet will "outfly and outclimb anything the USAF has in Europe," and the margin of superiority will be even greater when the Sabre VI enters squadron service soon, W. R. McLachlan, vice president and general manager of Orenda Engines, Ltd., told the Aviation Writers Assn. convention here. He said the Orenda 2, with 5800 pounds thrust, has been increased to well over 7000 pounds in the current versions, the Orenda 11, used in the Avro CF-100, and the Orenda 14 used in the Sabre VI. Since production of the all-Canadian engine began, he said, a total of about 2500 have been delivered, while weight has dropped from 2700 to 2400 pounds, and use of strategic materials has been cut by 40%. He said the current model is being produced at a cost of about $8 per pound of thrust versus the $10 normally considered a reasonable figure. McLachlan indicated Orenda is doing "a great deal of work" in the study and use of titanium alloys.

**FOR TOMORROW**

The Orenda general manager also declared his company would not be found "lagging in the race to meet the power requirements of the supersonic era."

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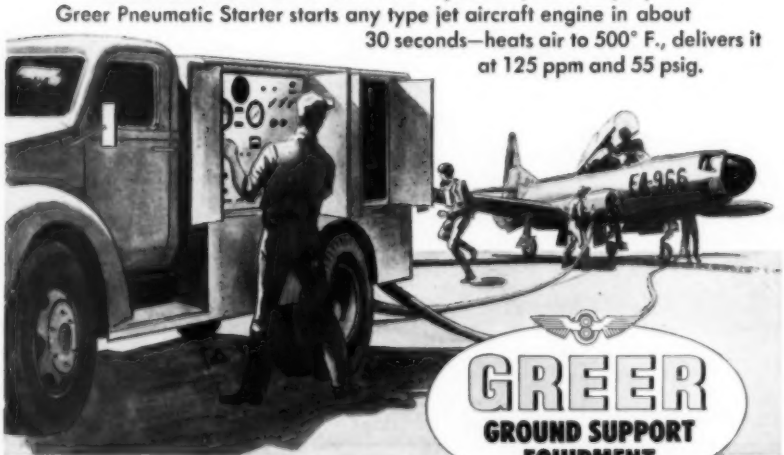

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thrust vector or "flying platform," thrust reversals for jets, improvements in seaplane hulls; hydroskis, to permit operations from water, and improvements in the application of boundary layer control.

• **Boundary layer control** can give worthwhile results. Relatively old, this means of reducing landing speeds appears more promising now, with the advent of the jet engine and the thin wing. The turbojet engine is a convenient air pump for boundary layer control, while the trend toward thin wings is complicating the design of effective wing flaps as an alternative for lower landing speeds.

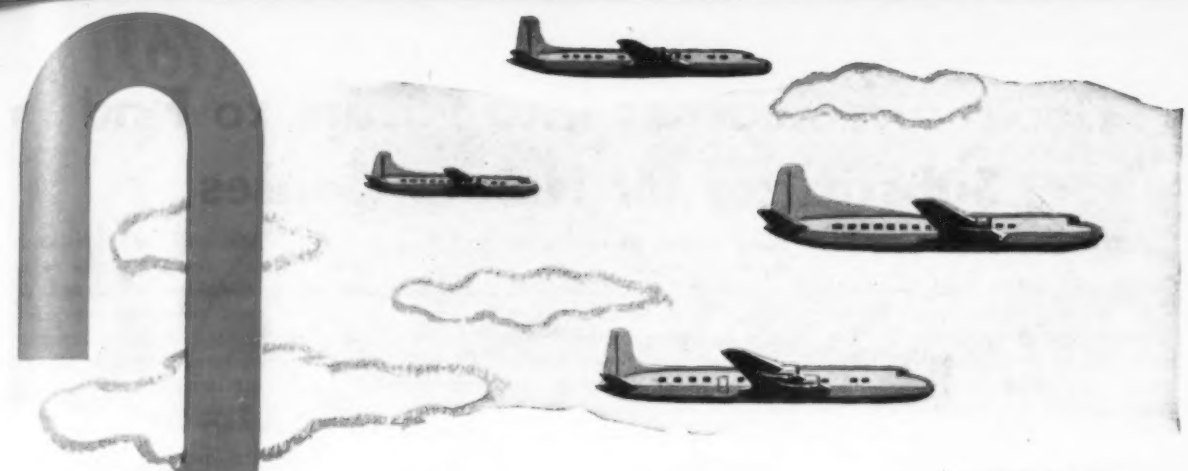
Worthwhile improvements in rotary-wing aircraft and the V/TO may be expected in the coming decade, with expanded use in military operations and in short hauls such as interurban and airport-downtown city travel, in commercial transportation.

Supersonic commercial jet transports are still off in the future. We expect to see a prototype of such a commercial jet flying before 1975. Meanwhile, civil air transport will utilize the high subsonic turbojets and turboprops now in the design stage. These will come into widespread use by 1960.

• **Aeronautical research scientists** are meeting the challenge of great problems. With marked advance in speed, however, problems requiring scientific investigation multiply. They multiply not only in number but also in difficulty, interrelationship and cost. Their timely solution by NACA is the most fundamental activity of the federal government in assuring America's continued qualitative superiority in aircraft. This, in the final analysis, provides our best hope to postpone successfully in our day, and to keep on postponing indefinitely, another world war, until international law and common sense shall prevail among nations and prevent an utterly destructive Last Great War.

In the meantime let us realize that aviation is but on the threshold of a new era. It has but entered the second half of the first century of its existence. Aviation is destined to revolutionize the lives of the people, even as the automobile has already done. World War II showed its capacity to alter the course of history and to reshape the destinies of nations.

With horizons and possibilities unlimited, the continued sensible development and application of aviation to useful purposes will accelerate the progress of civilization, raise the standards of living of all peoples, promote friendly relations between nations, and, more than any other factor, make possible the realization of the universal desire for world peace. ◆◆◆



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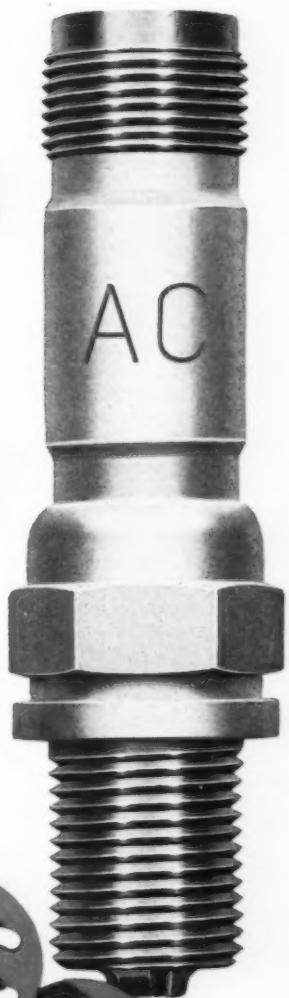


*For years the aircraft industry has searched for a spark plug with the following three characteristics:*

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*And, now all three of these vitally important characteristics are built into every AC Aircraft Spark Plug!*

"Blow-by" is virtually eliminated by AC's exclusive, patented "Conducta-seal" feature—a current-conducting seal of unusual strength and permanence made of metal and ceramic materials – fused together.

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*Man Too Slow for High-Speed Flight*

# Electronics Reaches into Future to Find Substitutes for Human Senses

By HENRY P. STEIER

THE saw that a military airplane is "electronics with wings" becomes increasingly apt as the dynamics of air warfare and air travel exceed the limitations of the human senses, posing a problem for both engineers and operators.

The operations of aviation today are conducted in an electronic environment, whether the pursuits of that industry be commercial or military. Man's mobility in both extent and time is so enhanced by new airframe and propulsion designs that so long as he is part of the man-machine mechanism he must be aided with some substitute for his nervous system and senses.

Electronics provides, to varied degrees, a substitute nervous system connecting man's senses to his environment. Pictorial displays, needle indicators, lights, sounds and dials present operators with information about the activities of a mechanism for which he is acting primarily as an error-detector. He is part of a control loop in which his thought, judgment, learning and decisions affect action through levers, knobs, handwheels, switches, and voice communication. Between him and the remote and near environment are the traditional "black boxes" with amplifiers, circuits, motors, computers, servo motors, power drives and antennas.

When man is removed from the control loop, as in the case of many missiles, radar, infra-red or other sensing mechanisms are substituted.

• **This is the realm** of electronics: to optimize quality of performance in man-machine mechanisms or weapons. The threat of nuclear weapons, the imposing magnitude of air traffic volume, and the need for all-weather flight both require ways and means of "unburdening" or "quickening" the human operator, to use the language of that new discipline, *engineering psychology*.

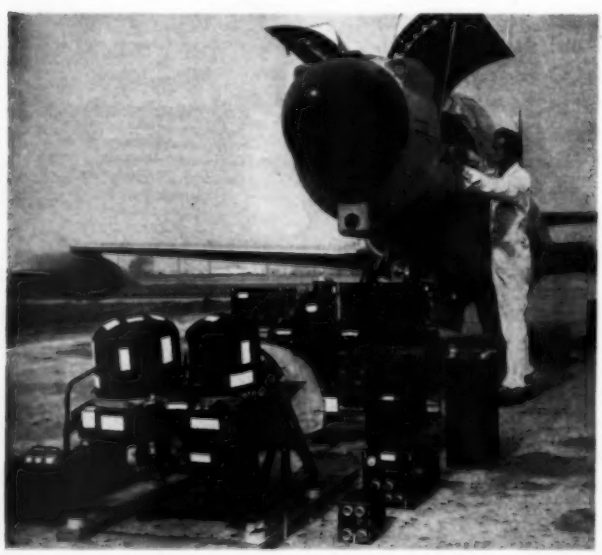
A highly efficient airframe, in the aerodynamic and fuel sense, may be totally ineffective without adequate internal and external guidance. To relieve the human of the task of integrating and knowing the effects of his responses is electronics' primary task and a major reason for its expanded use.

In discussing design philosophy for man-machine control systems, H. P. Birmingham and F. V. Taylor, engineering psychologists, Naval Research Laboratory, said empirical evidence leads to the view "that optimal man-machine control system performance can be obtained only when the mechanical components of the system are designed so that the human need act only as a simple amplifier." This would mean that for complex tasks where information must be united and differentiated with precision, the job is best done by non-human components of the system, leaving man in the role he seems most competent in a jet age to play, a transferrer of simple information.

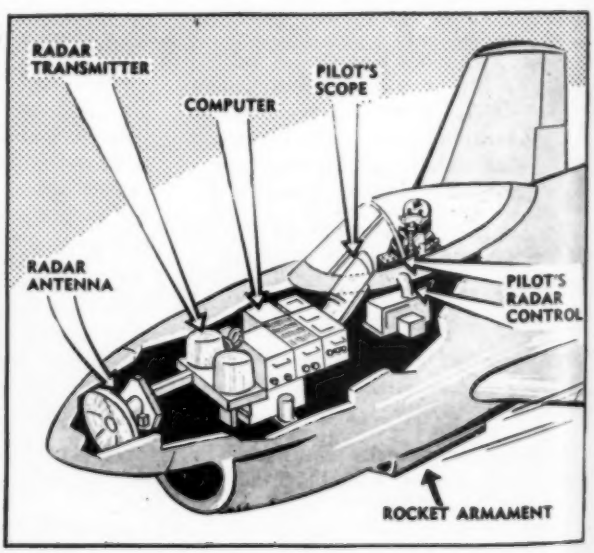
Posing the question of why after a system is designed so that only man-amplification is required, "one shouldn't take the step of substituting an actual amplifier in his place," the answer was that "if the design of the control loop permits the operator to reduce the displayed error more by acting as an integrator, differentiator, or a combination of these than as an amplifier, he will do so." Circumstances today are such that it is impossible to automatize operation completely, due to the state of the art, or because of blocks imposed by purse or politics.

### Packaging-Miniaturizing

• **Part of the price** of progress is complexity. Nowhere is this more true than in electronics. Reliability is often referred to as the "weakest link" or even as "impossible to achieve." There is no doubt that reliability is a watchword for equipment in aircraft and guided missiles. Long-range, multi-pronged attacks are being made on the problem in scores of projects such as



This mass of Hughes Aircraft Co. electronic equipment acts as the F-94C interceptor flight guidance and fire control system.




Radar sensing and electronic "brain" computing elements in the F-94C equipment that determine data to be displayed to the pilot.

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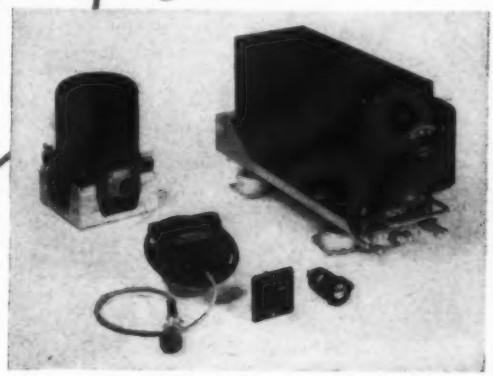

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# Four examples of how General in world-wide race

In 1942, G-E jet engines powered America's first jet aircraft, the Bell P-59A. Today, more G-E jets power Air Force planes than all other jet engines combined. The sleek Boeing B-47 bomber uses six G-E J47's. In addition, J47's power the nation's jet fighter mainstay, the North American Aviation F-86 Sabre Jet.

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First American turboprop engine built by G.E. had 2150 hp. Today, smaller, more efficient gas turbines promise better, power-to-weight ratio for helicopter and other aircraft applications.

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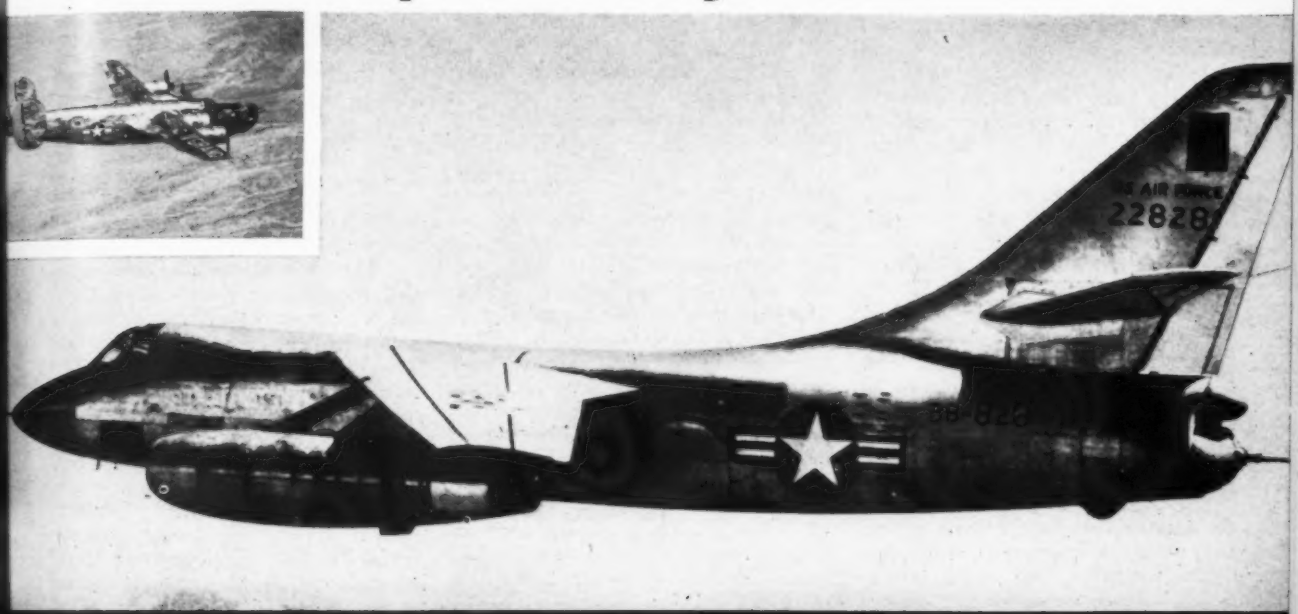
GENERAL ELECTRIC

# Electric helps U.S. progress for air superiority



World War II "Liberator" had gun turrets powered with G-E amplidyne drives, directed and fired manually. Today, newest TAC bomber B-66 has G-E fire control system which is radar directed by remote control.

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

G.E. supervised test development of V-2 rocket, shown above in first launching from U.S. aircraft carrier. Today, advanced G-E design rockets like the RV-A-10 provide new data on large solid propellant rocket motors for use on guided missiles.

*Progress Is Our Most Important Product*

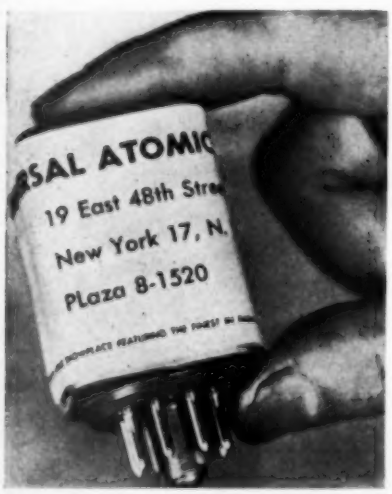
GENERAL ELECTRIC

Armour Research Foundation's study of the effects of harsh military environments on aircraft equipment, and Aeronautical Radio Inc. Military Contract Division work on electronic reliability as affected by electron tubes.

Designs for electronic equipment have changed drastically in the past few years. Packaging and miniaturizing has become a whole new technology. And, as expressed by Wilson H. Hannahs, Automatic Production Research Co., "beneath these casual generalizations is a whole new group of vital new principles in design, generated by the needs of providing equipment of increasing complexity which will yet be dependable in military environments."

• **The breakthrough** to mechanization of radio manufacture has a pronounced significance. Long accepted has been automatic production of chemicals and foodstuffs, but the focus today is on automatic production of electronics. From component packaging such as Tinkertoy modules to General Electric Co's Automatic Component Assembly (ACAS) machine, soon to be unveiled in operating form, the human operator is removed another step to promote uniform, reliable assemblies, in which poorly soldered joints, wrong wiring, shorted circuits, and a host of other troubles that have long plagued the old radio-television design philosophies, will be removed.

Wired circuits are being replaced by printed circuits or automatically wired boards. Axial lead components, automatically prepared in the ACAS machines, are inserted automatically, the units are dip-soldered automatically, and finally unit circuits are tested automatically with testers such as one designed by Color Television, Inc.




An encapsulated power supply that develops 1500 volts from a 1½-volt dry cell battery.

• It has been said that "90 percent of electronic troubles are traceable to quality of components and assembly workmanship." The marked trend to packaging functional circuits as plug-in assemblies is both a logical one for mechanized assembly, and reduced maintenance costs and time. Encapsulation of complete functional circuits to withstand extremes of temperature and shock are the next logical step in the developments towards reliability and easy servicing.

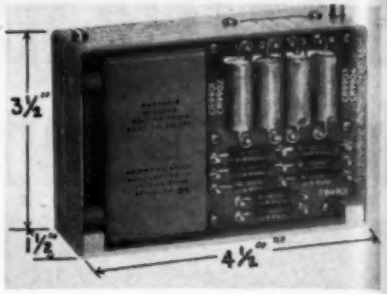
There are proponents of the "throw away" school, who believe such encapsulated functional, and standardized circuits could be made cheaply enough to allow discarding them at the end of their useful life.

• **A revolution** in materials is aiding the reliability-packaging trends. The ingredients of this materials revolution are what Dr. Elmer E. Engstrom, executive vice president, research and engineering, Radio Corp. of America, referred to recently as "electronically-active solids." These are the transistors, photoconductors, ferromagnetic ceramics, ferroelectric materials, electroluminescent materials, thermoelectric materials. These materials are effecting a fundamental change in electronic science and in the future this trend will gain in magnitude.

The electron tube, which became the "lever-arm" of electronics, is undergoing change to permit matching the rugged reliable quality of transistors. Stacked ceramic-metal tubes, such as those developed by Eimac, Sylvania and General Electric, promise new standards of performance, gains in reliability and possibility of automatic assembly.

• **Bright star** on the encapsulated circuit horizon is the magnetic amplifier. It has emerged after lying dormant for nearly 40 years since Dr. Alexanderson used it to control the output of his alternator in 1916 for radio telephone transmission. The Germans used it, however, to some extent in their V-1 buzz bombs of World War II. Its use today is phenomenal, considering how a few years ago it was relatively unknown. It is no longer a laboratory device, and the marriage of vacuum tubes with transistors that was gaining headway last year, is today being supplanted by magnetic amplifier combinations, particularly in output stages where former tube-transistor combinations gave efficiencies of 50 percent.

The new combination gives 50 to 70 percent with far greater reliability. Most vacuum tube failures are reported to occur in the power-handling output stages. Magnetic amplifiers require no large dc or plate supply source




A magnetic amplifier used in the computing circuits of Collins Radio Co.'s AP-101 automatic pilot. New magnetic alloys and improved selenium rectifiers made small, efficient magnetic amplifiers possible.

and can operate from main ac sources. Weight and size are reduced.

• **In the guided missile field** and in aircraft, as in the latest Collins Radio Co. equipment designs coming off the board, reliance on magnetic amplifiers is high. They are becoming a standard part of servo controllers. Highly resistant to shock, vibration, and temperature extremes, with no moving contacts or parts, requiring no warm-up time, long lived, the magnetic amplifier can be sealed and potted to form a durable component. Some deterrent to their widespread use might result from lack of engineers trained in the design and utilization of the device, and there is a dearth of textbook material about such devices.

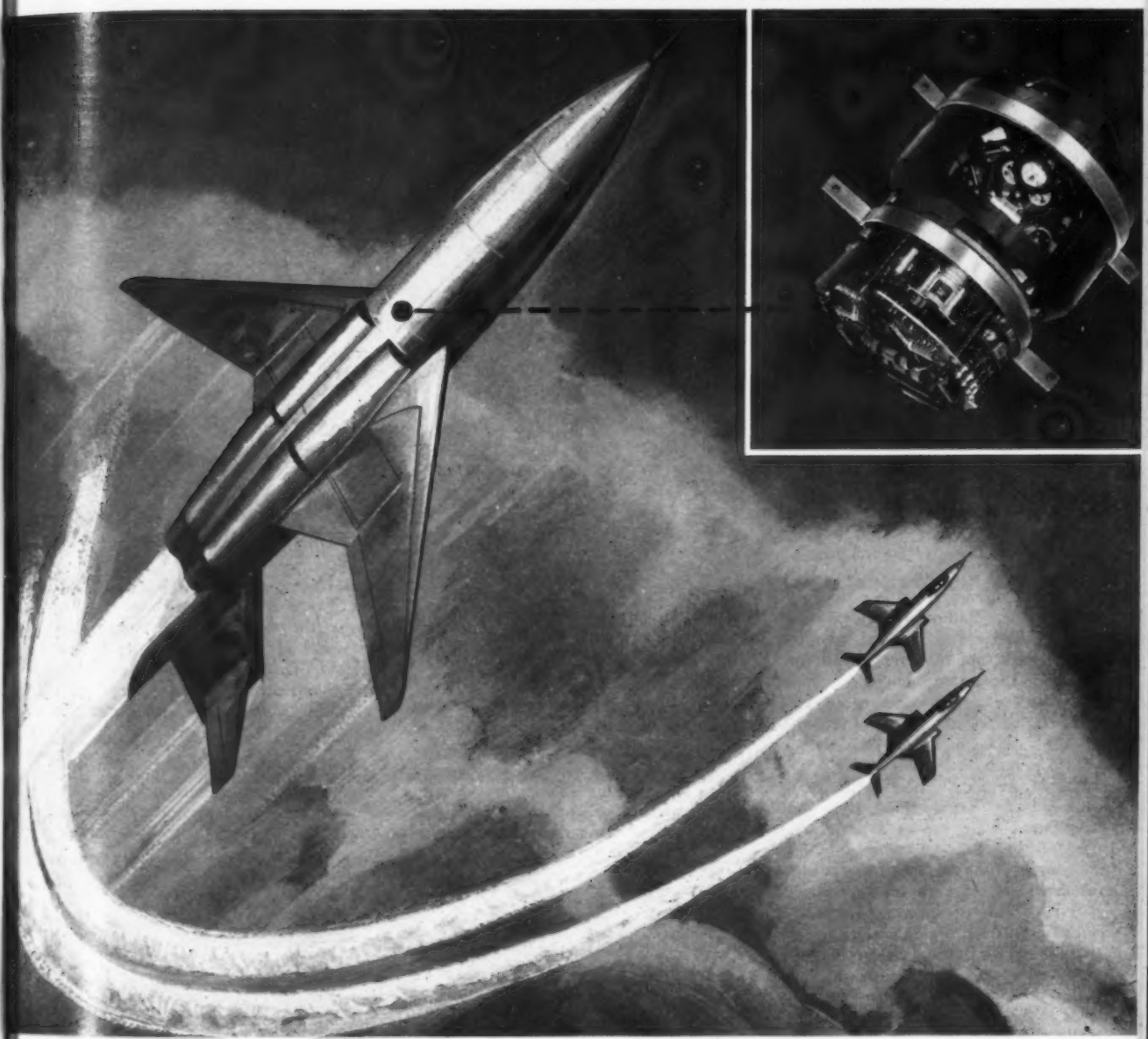
In the field of solid-state devices, transistors have achieved the most prominent place. Their limitations as generators of radio frequencies and in power handling are a handicap to fuller utilization of them. Recent Bell Telephone Laboratories statements concerning transistor operation at 1,000 megacycles experimentally denote gains toward their use some day in that part of the radio frequency spectrum. This, incidentally, is a region marked for the Common (Military-Civil) Air Traffic Control system foreseen by the RTCA Special Committee 31 in 1948. For the present they remain low level small signal devices and their use in such applications is assured, although transistors with class A output ratings of over 50 watts have been successfully designed and fabricated, according to a report from N. H. Fletcher, Transistor Products, Inc.

### Ferroelectric Material

Second to transistors in increasing importance, in the primary component area, are the ferroelectric materials that assume growing importance as information storage elements in digital computers for both airborne and ground environment use. The use of digital rather than analog techniques for automating aircraft, weapons control and

# Bendix 3-GYRO STABLE PLATFORM*

*Developed in conjunction with Flight Control Laboratory, Wright Air Development Center



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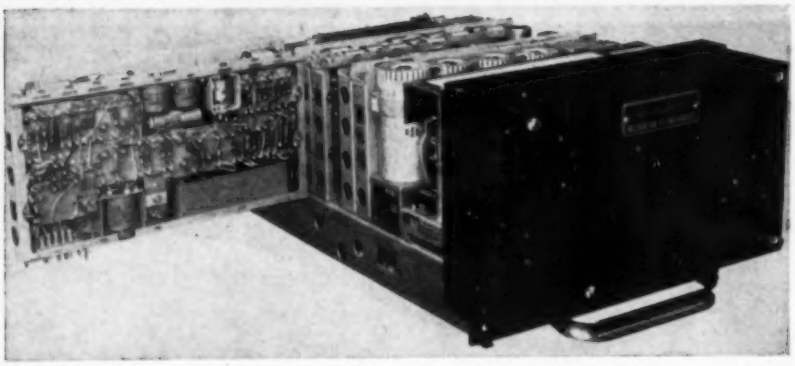


Airborne TACAN ARN/21 equipment showing how plug-in functional circuit "unitized" panels are packaged for easy removal and servicing.

navigation was pioneered in 1948 by Hughes Aircraft Co., which constructed a computer named "Digitac" (Digital Tactical Automatic Control) using a magnetic drum for storage of pulse information. The accuracy of digital mechanisms is high and "limited only by the desired reading or counting speed," according to R. J. Bibbero, Hillyer Instrument Co. He compared them with "analog devices accurate to 0.1 percent of the unambiguous base measurement." This line of reasoning led to its selection for Digitac.

The Digitac, according to Engene M. Crabbe, Ramo-Wooldridge Corp., proved that airborne digital computers are practical not only for control functions, of the system, but for a variety of auxiliary computations like cruise control, air data reduction, predicted time of arrival and other problems.

The magnetic core, a ferroelectric material, in the shape of a tiny doughnut slightly larger than a pin-head, has found wide use as a memory device.

Great promise lies in the ability of each tiny core to store one binary (0 or 1) bit of information over an indefinite period until told electrically to relinquish it. Efficient electronic memories equipped with thousands of the cores are a major advance over complex vacuum tube circuits in their ability to "recall" any item of stored information within millionths of a second. Rapid solution of complex problems and swift compilation of large quantities of data by air and ground computers is a need that must be met by compact automatic equipment.

International Business Machines Corp. is engaged in the automatic production of air defense computers, probably for the SAGE (Semi-Automatic Ground Environment) data transfer system the Air Force expects to be operating about 1958. The computers require thousands of printed wiring assemblies, and this is being done automatically with Autofab, automatic assembly machine developed by the Mechanical Division of General Mills.

With the increase in aircraft speeds and higher operating altitudes has come the need for better-performing and higher-powered ground radar equipments with better target resolution. The kill-rate against enemy missiles or aircraft must be as close to 100 percent as possible. This means detection at the greatest range, positive identification, and interception way-ahead of the bomb release point. In the modern missile case man is no longer in the control loop to monitor and correct. In the commercial aircraft case, positive identification of specific flights is needed to insure smooth traffic handling and control, as well as accurate airport surface detection equipment (ASDE).

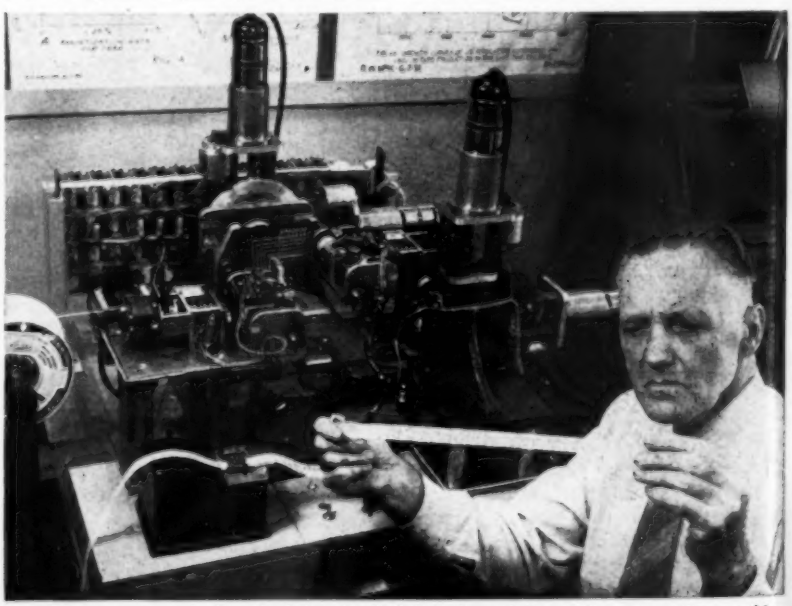
Key to the high resolution problem is generally accepted to be the use of the highest practical frequency. Here the limiting factors are the frequency limits of the magnetron tube used for generating the powerful pulses used. Much of the work with these tubes is classified, but some idea of current progress is gained from a report by J. E. Woodward, Airborne Instruments Laboratory, on an AN/CPS-8 Taxi Radar built for the Air Force.

Operating at 24,000 megacycles, with a beam width of only 0.4 degrees, tests were conducted at Idlewild Airport, New York. Satisfactory results are reported. On one occasion a horse that strayed onto the field was detected with the aid of the radar, and it was then possible to vector a truck to the horse with a minimum of delay. The experimental ASDE radar is credited with preventing a plane from turning onto a live runway that had been mistaken for a taxiway. In tests, a man could be seen walking around a small airport vehicle on the field. Work on an engineering model of the ASDE is expected to be completed late in 1955.

Another important tube area is that of microwave traveling-wave tubes, and backward-wave tubes that are characterized by their ability to be tuned over a wide range of very high frequencies in the 6,000 to 70,000 megacycle region by variations in plate voltage. There is urgent need to deny an enemy the use of his electronic aids through Electronic Countermeasures (ECM). To do this broad-band, high-power devices are needed, and such devices are among the most difficult to design.

### Frequency Management

A task of enormous technical complexity, known as *frequency management,* faces users of the radio spectrum.



Complex apparatus can be wired by this Bell Telephone Laboratories automation machine using instructions punched on a paper tape to guide the cams and gears.

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There is a limit to use of this resource common to all nations. The number of electromagnetic waves that can be received intelligibly without interference must be carefully and efficiently used, both nationally and internationally.

In the present period we are faced with the problem of adjusting the use of radio frequencies for handling ever-mounting volumes of telecommunications traffic. Pressures have reached a point in the radio spectrum that runs from 10 kilocycles to 30,000 megacycles, where the federal government may be forced to institute a policy of re-evaluating frequency utilization. The assignment of radio spectrum space among private users is the responsibility of the Federal Communications Commission, but the amount of space available for assignment is the President's responsibility, as is the management. The Interdepartment Radio Advisory Committee is the instrumentality through which frequencies are assigned to Federal users.

In 1950, President Truman created a Communications Policy Board to study the problem. Its report, issued in 1951, found "little to go on." It said: "Existing policy is meager, and varies from self evident generalities to filigreed treatment of highly specialized detail."

"Thus far," the report continued, "no national policy has existed to clarify this dual control of a single resource and thus to aid in governing the apportionment of space between private users and Government users as groups. No criteria have been established for use in choosing between the conflicting needs of a Government and a non Government user.

• **Recognizing telecommunications** as the vital nerve system of modern military establishments the board recommended a continuing mechanism to deal with the situation and thus avoid transfer and retransfer of spectrum space. The Board went out of existence after its report was submitted. To "get into the clear," the Air Force in 1952 converted their airborne communications from the crowded VHF to the UHF region. Every single ground station and airplane was involved. The AN/ARC-34 airborne equipment was developed. It provided the AF with 1,750 channels for line-of-sight communications. The maximum frequency spread from VHF to UHF was 100 to 400 megacycles, a four-to-one ratio.

The separation between frequencies to avoid interference has been decreasing because of improvements in stability and selectivity of equipment. Big difference between UHF and VHF is equipment complexity. Use of quartz crystals to control frequency stability in a 1,750-channel system would have meant an unmanageable amount of plug-in crystals to handle the band.

Frequency synthesizers are used in AN/ARC-34 to permit use of only a limited number of crystals to provide crystal control on any frequency in the band. The greater channel capacity of this AF equipment is a move in the right direction to efficient spectrum utilization that may some day be part of the answer to the needs of the civil private flyer and commercial airline user of spectrum space.

The TACAN system of air navigation developed by Federal Telecommunications Laboratories is an example of efficient spectrum utilization. At present it effects a considerable saving by operating both azimuth and distance

Magnetic cores, intricately woven into copper-wired frames like this, form the memory elements in the 700 series IBM electronic data processing machines.

information services in the same band, with possibilities for combining many other additional services in the same band as developments continue. Someday the VHF band used for present omnirange stations may be released for other services.

• **At present** the only way to move is *up* in frequency, but the techniques and complexities of UHF utilization are lagging behind the traffic needs. Some progress toward more efficient use of frequencies in the 30-to-1,000 megacycle region, where generating and equipment techniques are fairly well established, but where line-of-sight propagation limits are a handicap to long-haul service, is seen in the recent discovery of scatter propagation. This effect permits a large extension in the range of transmitters operating above the 30-megacycle region.

### Scatter Networks

A rough rule previously applied to vhf and uhf transmission was that reliable signals could not be received very far beyond the optical horizon. High antennas were customary to increase the range. It was learned that with small beam angles and high-gain antennas, and high transmitter power, multi-channel communication over distances of 200 miles can be achieved in the UHF band. The waves are scattered downward in the troposphere, a region about 30,000 to 50,000 feet above the earth.

Where it is economically unsound, or physically impossible to establish relay stations between each horizon-to-horizon point, as in the arctic regions, scatter propagation offers good advantages for long-hauls as in the network of early warning radar being installed in depth from the arctic to the U.S. It is believed that a chain of scatter propagation stations will relay information to the IBM air defense computers in the U.S. from the polar regions about enemy missiles or aircraft that are detected by the powerful radars installed there.

The savings in number of stations needed will be tremendous and the directed beam characteristics of the signals offer some protection from misuse of the signals by an enemy. The quality and reliability of scatter propagation compares favorably with wire lines. Bell Telephone Laboratories, Collins Radio Co. and Federal Telecommunications Laboratories are known to be actively engaged in developing equipment for the new technique.

• **Present scatter systems** are believed to have bandwidths of about 600 kilocycles, which permit a possible 150 telephone channels, but the need both for military defense and for the Common Air Traffic Control system implies a requirement for providing video data from long-range radars. The RTCA SC-69 is investigating the problem of handling such data for air traffic control centers that will ultimately be needed for radar control over en route areas and wider coverage of present terminal ATC areas.

To increase the usefulness of radar for control of air traffic in terminal areas, the ATC Airborne Transponders and ATC Ground Interrogators will soon implement traffic handling. Transponder designs are being readied by Wilcox Electric Co., Collins and others. The need exists to provide the lowest cost and weight possible so that economic considerations will allow maximum utilization of the facility by all classes of aircraft. The system will further aid the country's air defense network, since both military and civil will use the system.

General P. C. Sandretto, technical director, Federal Telecommunications Laboratories, in discussing elements of the air traffic control problem, said: "It is important for the electronic designer, while he is devising ingenious schemes for the solution of the traffic control problem, to remember that the character of the equipment, if it is to result

# The "Hercules" of hoses flies with the Lockheed Hercules

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"Herculean" strength and endurance also characterize the Fluoroflex-T hose assemblies that convey fuel and oil on this plane and on its four turboprop engines.

Fluoroflex-T R3800 hose assemblies represent the latest word in aircraft hose progress. They're 500°F lines. These are the hose assemblies using a tube compounded from Teflon that have A-N approval for synthetic fuels, oils and nitric acid.

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Republic's F-84F Thunderstreak and RF-84F Thunderflash

*Photo courtesy of Republic Aviation Corp.*

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The Peirce Airborne Voice Recorder Model RD-106/ANH-2 is used in jet aircraft to record pilot observations in flight operations by the USAF and other military services.

With the cooperation of the Communications and Navigation Laboratory at Wright Air Development Center, Peirce developed this unit for making voice, radio set and intercommunication recordings in all flight, weather and altitude conditions. A 60 minute removable, reusable magazine is used.

Model RD-106/ANH-2
Size: 5½" x 6½" x 9⅛"
Operating Voltage: 27 Volts D.C. at 2.5 amperes

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in a sufficient solution, must be geared to the nonelectronic factors."

• **Man is probably** the most important element. While he is "in the control loop" the best use must be made of his senses. Several of his senses can serve as input channels through which he can detect changes in the state of a controlled mechanism. Vision and hearing have been utilized. Vision, however, has been mainly exploited. It is the only sense that permits accurate apprehension of geometrical space, or three dimensions. This sense has acuity, or accuracy; form perception, enabling it to recognize objects such as landmarks or targets. The eye knows the difference between an aircraft and a cloud—not always the case with radar. This sense cannot be jammed by electronic countermeasures. Birmingham and Taylor believe this last feature "gains importance as electronic sophistication increases on the part of prospective foes."

The cathode ray tube offers the best promise of showing man a pictorial representation of data in the information loop of which he is a part. The Willys flat cathode ray tube of rectangular shape and only a few inches thick has been proposed as a means of eliminating the necessity for pilots to integrate needle or other indicator techniques for presenting information.

Proposals ranging from displays showing terrain and aircraft over it to diagrammatic displays have been presented. The Teleran system, on which the writer, then associated with RCA, worked a few years ago, was a time-shared system comparable to TV, but with different frames of the picture carrying different information in pictorial form. It failed because it needed 4.5 megacycles of bandwidth to carry its signals. Wide band methods are generally subject to the requirement for large values of signal strength which are difficult to establish beyond the horizon at the vhf and uhf frequencies generally used, and are subject to multipath effects. While the Willy's tube has prospects, the high voltages, in the order of 10,000 volts for beam acceleration, are difficult to insulate at high altitudes and would require a highly pressurized environment.

According to V. Weihe, Melpar, Inc. div. Westinghouse Air Brake Co., Melpar is investigating a display technique using RCA's bright trace cathode ray storage tube. He visualizes a system needing no more than three kilocycles bandwidth and using a lantern slide technique of framed information, perhaps stored in "bit" form. Different frames of information could be sent to different altitudes. Punched cards in a computer on the ground could be the source of "bit" information transmitted.

A material that could easily be part of any future pictorial display has the property of electroluminescence—the direct conversion of electrical energy into light. This is commonly called "light amplification." The General Electric Research Laboratory has demonstrated a device using a solid-state luminescent phosphor mounted on a glass plate. A very dim ultra-violet light image projected on the plate can be amplified to produce a visible light image of high brightness. When voltage is applied across the phosphor crystals, light is emitted. The quantity of light may be varied by changing the voltage. This leads to the possibility for greatly simplified production of bright displays involving less complicated and cumbersome equipment.

### Nuclear Control

There are estimates that instrumentation sales for nuclear propulsion reactors for aircraft and ships will total $50 million by 1963. It is a field that challenges control means which must be accurate and fast, operating on a servo loop basis.

The job of controlling reactors usually falls to control rods of boron or cadmium. These are the movable neutron absorbers called "shim, safety, or regulating rods," depending upon how much fineness or coarseness of control they exert. Generating the information loop about the state of the reactor will be the job of electronics. The tedious adjustment process and need for accuracy makes automatic control necessary.

The effects of nuclear radiation on electron devices is under serious study at this time under classified projects. One of them, the effect of nuclear radiation on transistor operation, is most serious, since there is good reason to believe that radiation will alter their characteristics. This effect will undoubtedly be felt as other solid-state devices come into common use.

### Space-Electronics

The problems of electronics in space flight are not well established. The satellite project, for which the Glenn L. Martin Co. is developing a launching vehicle, and which will be used as part of International Geophysical Year program, should do much to clear the air on many space-electronic problems. Space flight may, however, present other electronic hurdles to be overcome when flight beyond the satellite altitude becomes feasible.

Bouncing radar signals off the moon has been successfully accomplished and is convincing evidence of transmission possibilities. ◆◆◆

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Cooling units can be modified as required for varying conditions encountered in land or sea as well as aircraft service. Almost all units are designed to meet such specification as MIL-E-5400 and MIL-E-5272.

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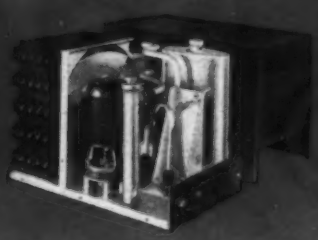
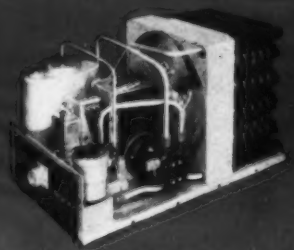
Eastern welcomes your consultation on liquid cooling problems ranging from 200 to 20,000 watts dissipation.

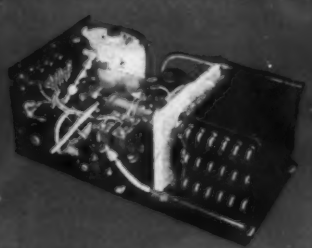
**Write for Aviation Products Bulletin 330.**



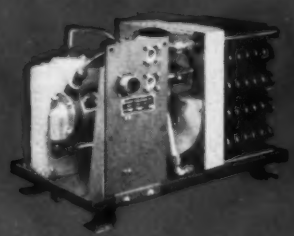
**MODEL EE-175, TYPE 200** DISSIPATION: 2,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 15-13/16" x 10¾" high.



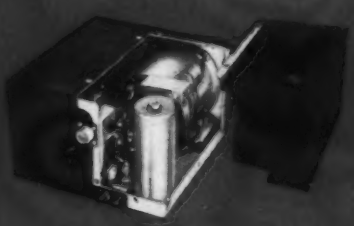
**MODEL E/HT-205, TYPE 200A** DISSIPATION: 1600 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 21" x 10" high.



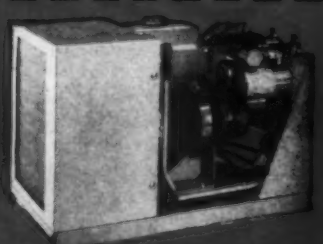
**MODEL EE-177, TYPE 202** DISSIPATION: 1700 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 110 volt, 400 cycle, 3 phase. WEIGHT: 27 pounds. SIZE: 10" x 19 15/32" x 7⅞" high, per JAN-C-1720A, size B1-D1.



**MODEL E/HT-210, TYPE 200** DISSIPATION: 1500 watts. ALTITUDE RANGE: sea level to 10,000 feet. POWER REQUIRED: 208 volts, 400 cycle, 3 phase. WEIGHT: 35 pounds. SIZE: 11¼" x 19½" x 12½" high.



**MODEL E/HT-200, TYPE 201** DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 14½ pounds. SIZE: 10" x 10" x 6" high.



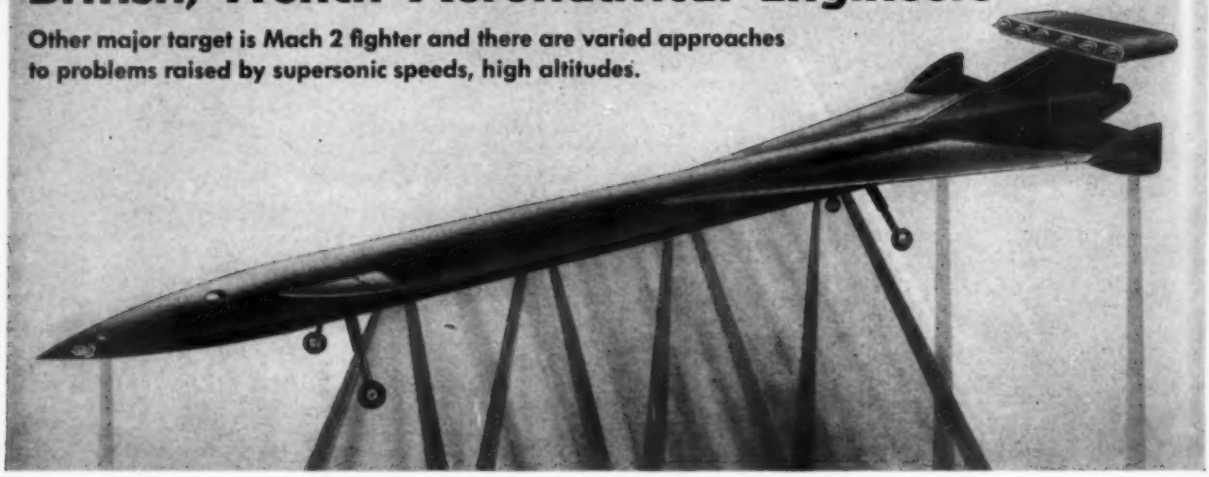
**MODEL NO. 5-A** DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 100 to 110 volts D.C. WEIGHT: 10 pounds. SIZE: 7⅛" x 13½" x 9-1/16" high.



Circle No. 22 on Reader Service Card.

# Elimination of Runway Is Key to Thinking of British, French Aeronautical Engineers

**Other major target is Mach 2 fighter and there are varied approaches to problems raised by supersonic speeds, high altitudes.**



## JET FLAPS AND SHORTER TAKE-OFFS

By JAMES HAY STEVENS

LONDON—Probably the key to, or inspiration for, European aeronautical thought today is the elimination of the runway.

Every way one looks one sees evidence of attempts to put runways in the discard—at least that is how it seems at first sight. Military and civil thinking is directed to the same end, even though the means are usually widely different.

Peter Masefield, retiring Chief Executive of British European Airways, has said much upon the importance of city center-to-city center operation, first by the 40/50 seat helicopter, later by VTOL airplanes. He appears to favor the Rolls-Royce approach to this problem; that is, straight jet lift, with special engines for that purpose alone, and subsequent supersonic cruise.

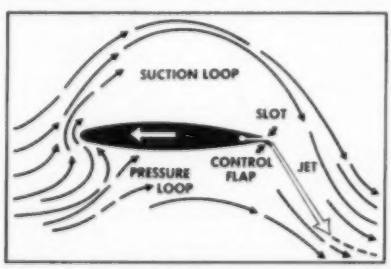
High thrusts, eventually exceeding the initial gross weight, of new military airplane specifications point the way to VTOL with little adaptation other than jet deflection devices. In fact, the Westland-adapted Nene-Meteor with the U. K. National Gas Turbine Establishment's jet deflectors is a move in this direction—although this particular installation is for landing *only*.

• **The recently-revealed Jet Flap,** also of the NGTE, is another approach to shortening airliner take-off and landing. This is an extremely promising device which is, in effect, a combination of the principles of jet deflection with those of super-circulation. The entire engine jet stream is ejected through a slot along the whole wing trailing edge to integrate propulsion with lift.

Although still in the laboratory, the jet flap potentially offers the solution for airplane city-center operation from roofed-over railroad terminals. Airplanes meeting I.C.A.O. accelerate-stop requirements in 750 feet using four interconnected turboprops are envisaged by NGTE engineers I. M. Davidson, N. A. Dimmock and B. Stratford.

Mainliners and long-range airplanes might well be designed requiring only 3,000-foot runways. Compared with other short take-off devices, the jet flap has the advantages of not carrying dead weight (e. g. the two sets of engines in the Rolls-Royce "Flying Bedstead" concept and the various convertiplanes), and of not requiring any awkward attitudes or special ground equipment.

• **The jet flap** has been under development at the NGTE since 1952 and, with one of those coincidences so common to inventions, Poisson-Quinton and Jousserandot of France's Office National d'Etudes et de Recherches Aeronautiques (ONERA) have been working along similar lines.




JET FLAP IN ACTION for maximum lift, zero incidence, 60-degree deflection.

In a recent lecture on dispensing with runways, Georges Hereil, President of the S.N.C.A. du Sud-Est, said that all major French companies have a VTOL project on the drawing board. The core of Hereil's lecture, however, was an outline of the various attempts to substitute skis, trolleys, catapults or ramps for wheels and concrete. Not unnaturally, the independence of the Baroudeur attack fighter, with its use of skis or trolley from any terrain, was emphasized.

• **Second major European target** is the Mach 2 fighter. Most of the entrants for this race are veiled in deepest secrecy, but France has given some details of a couple of fancied starters.

The S.N.C.A. du Sud-Ouest Trident dual-power research airplane is the forerunner of an armed supersonic interceptor. The French company's approach is to base performance on a three-barrel rocket and low wing drag due to a tiny, thin straight wing.

The rocket maintains power and therefore high rate of climb and performance to some 60,000 feet—perhaps more. The price is paid in high fuel consumption, while the French choice of nitric acid as oxydant makes the airplane a most unpleasant vehicle for pilot and population alike. Tip-mounted Armstrong Siddeley Viper turbojets give about 3,500 pst for cruising back to base, showing that the rocket is the *main* power plant.

René Leduc, working on his own, inventing all his needs—control boosters, pumps, high-capacity fuel gauges inte-

THE INFORMATION ON THIS PAGE IS TYPICAL OF THE DATA YOU WILL FIND IN THE NEW AIRBORNE CATALOG

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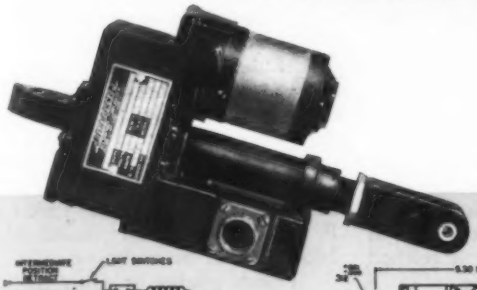

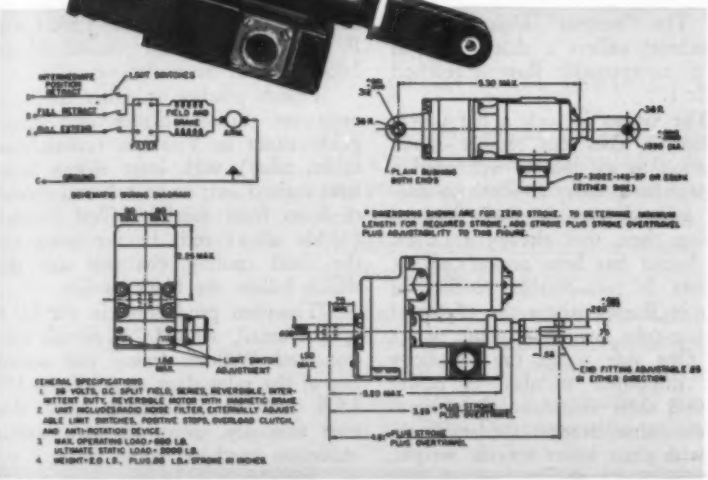

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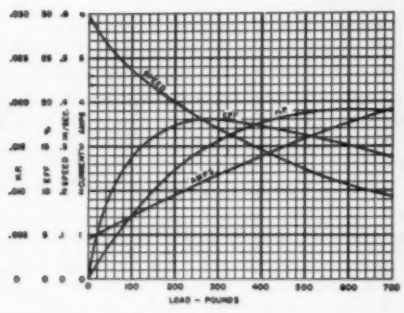
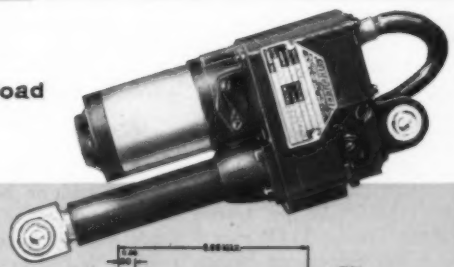


## R-584

**650** lb. max. op. load
**wt. 2.0 lbs.**



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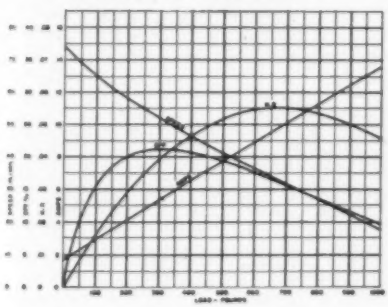

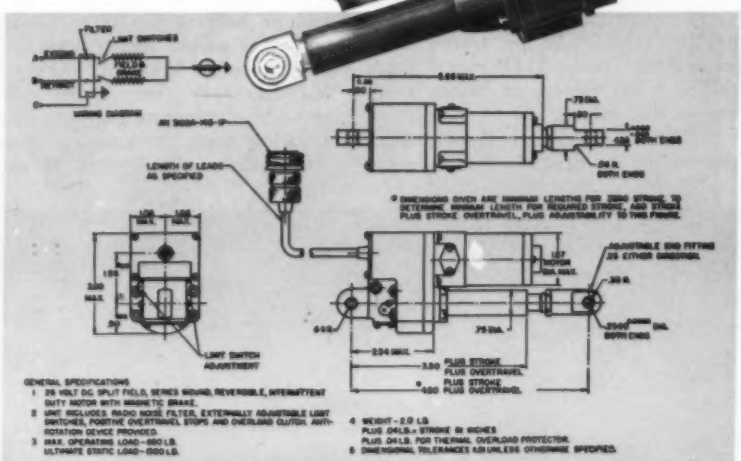

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gral construction—is well up in the Mach 2 race. The first prototype of his 022 fighter is now nearing completion at Argenteuil.

Leduc's theory is that the only way to provide the high power factors necessary for maneuvering in supersonic flight is the ram-jet. Logically, he designs his airplane as a ram-jet, puts the pilot in the nose bullet, adds fuel-carrying wings, and an Atar take-off turbojet at the rear of the nose bullet. Here the turbojet is again used for return to base, also for acceleration to perhaps 600 m.p.h., when the ram-jet power is beginning to rise and its economy becomes reasonable.

Above Mach 1 the ram-jet becomes steadily more efficient and at Mach 2 it may well give the best power for fuel consumption—certainly it will be far better than the rocket. Leduc claims his ram-jet can operate up to 80,000 feet, or two miles higher than a turbojet.

• **Third European approach** to the Mach 2 fighter is the de Havilland formula, most simply tabulated according to the company's Farnborough placard:

• Gyron + afterburner for *take-off* and *climb*.

• Gyron + afterburner + Spectre *to maintain climb* and give *rapid acceleration* to supersonic flight.

• Gyron + afterburning to *maintain* supersonic speed.

• Gyron + afterburning + Spectre to *attack* and *maneuver* at supersonic speed.

• Gyron alone to return to base.

Although based on company products, the 15,000 pst Gyron turbojet and the Spectre HTP rocket motor, this is a fair picture of British thinking in this sphere.

The de Havilland Gyron, is *the* powerplant for Britain's 1960-'70 supersonic airplanes. It is a huge steel engine—46¼ in. diameter, 154 in. long—with a simple single-spool axial compressor of low pressure ratio. The low pressure ratio means a subsonic fuel consumption akin to that of a centrifugal turbojet of the last generation, but allows the engine to accept the 6 to 1 and upward ram intake compression of Mach 2 to 3.

The whole concept of the Gyron has been based on supersonic flight, and it is the only known turbojet so designed. The "normal" high pressure-ratio turbojet suffers a sharp drop in power as compressible flow is reached at Mach 1.

• **The Gyron** is such a big power plant that it does not require much imagination to see that it will need a large airplane to carry it—both to contain it and to store its fuel. Scarcely surprising, then, that already a D. H. Gyron Junior has been announced.

There is considerable conflict of opinion in Europe about the effects of the square-cube law on airplane power plants. One side wants the simplicity of the minimum number of power units—and their attendant plumbing—while the other believes the small engines, with their lower specific weight, will make the best compromise. The extreme in this school is the Rolls-Royce idea of a supersonic airliner literally blowing itself into the air with a battery of tiny turbojets, later to be propelled horizontally by another set of engines.

A. G. Elliott of Rolls-Royce has said he believes this type of transport will come within twenty years and will give not only very rapid (city center), but also very cheap, travel. Weight saved by eliminating gear and flaps and reducing wing to cruising minimum requirements are expected to compensate for "duplicate" engines—and the jet-lift fuel.

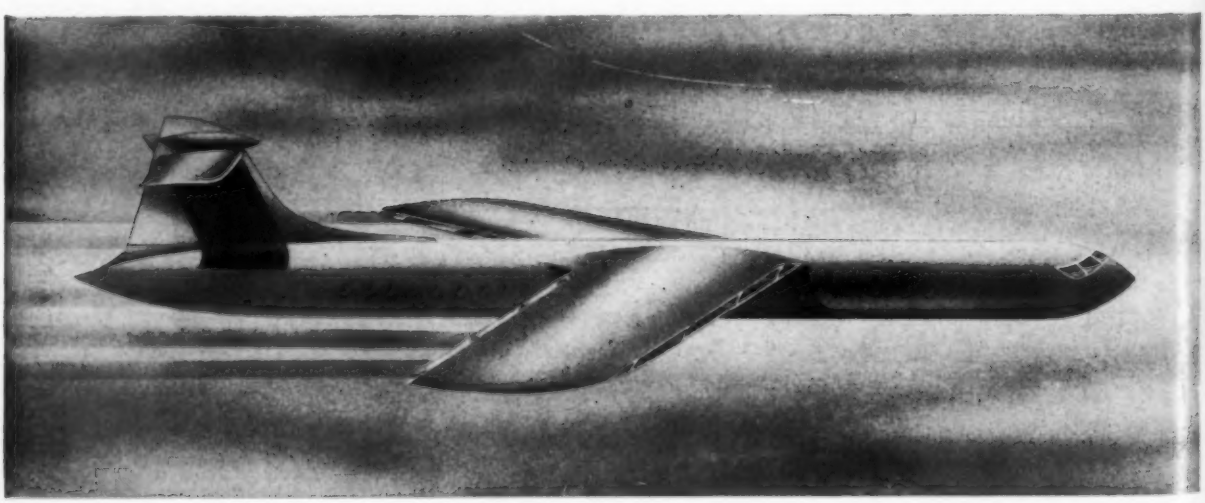
• **A significant detail** in turbojet development is the British advance in cooled turbine blades, extremely necessary to allow higher operating temperatures. Such a development permits greater thermal efficiency to contribute lower fuel consumption in subsonic flight. At high supersonic speeds the air leaving the compressor, even in the stratosphere, will be around 900° F, leaving little heat rise available for combustion before the critical 1,500-1,600° F is reached. With cooled blades, 2,060° F can be withstood.

British practice is either to investment-cast turbine blades and nozzle guide vanes in Vitalium (cobalt/chromium alloy) with inset silicon tubes, later melted out; or to roll and extrude to form from axially drilled Nimonic (nickle alloy) rod. In the latter case the final cooling channels are slots which follow the blade profile.

Titanium production in the U. K. is still small, with I.C.I. Metals Division and William Jessop just coming out of the pilot-plant stage. From 1956 I.S.I. will be producing 1,700 short tons annually, using its own sodium reduction method, while Jessop's output initially will be 400 tons from a U. S.-type plant.

Other European countries appear to have negligible capacity, except Western Germany, where Krupp of Essen, excluded for ten years from military development, used the crystal ball to decide that titanium would be *the* crying aviation need of the second half century. The result is an unequalled ability to fabricate the material—raw or alloyed—and a potential output claimed to be on a par with U. S. capacity.

• **It is generally conceded** by the



A JET FLAP AIRLINER. Leading-edge slit air intake helps boundary layer control and, with entrainment due to jet, would cut drag.

NUMBER 3 OF A SERIES

# INTEGRATED ELECTRONICS

THE IMAGINATION FOR RESEARCH PLUS THE SKILLS FOR PRODUCTION

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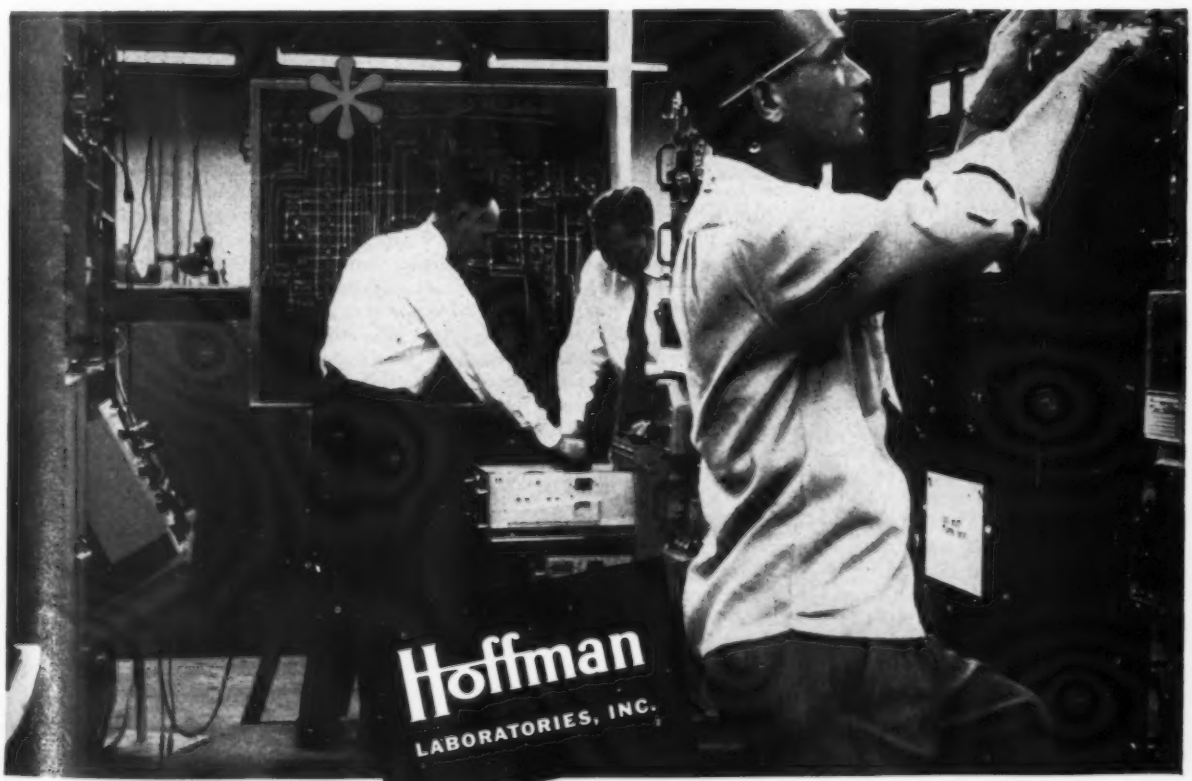


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leading European technicians that the aviation problems of the next decade are material, rather than aerodynamic ones. The "heat barrier" is looming very close at Mach 2, and even before that the turbojet—and its surrounding structure—are in severe difficulties.

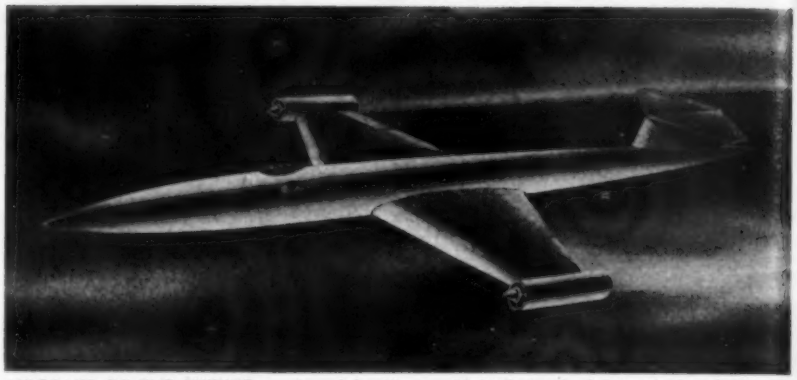
With the importance of frontal area so paramount a drag factor in supersonic flight, the cooling air needed to shield the airplane structure from radiated engine heat is an ever-increasing drag penalty. Next come the difficulties of canopies, insulating materials, etc., adding one upon the other until the actual airplane structure is involved. Forward thinking envisages a Mach-heat life for components, and even the whole airplane, due to the cumulative effect of heat soakage and creep on virtually all usable materials—it could be likened to a "heat-fatigue" problem.

In less exalted spheres, the very real difficulty of mechanical fatigue in light-alloy structures is being vigorously studied, particularly in the U. K. Some scientists think that the cause of the break-down of a molecular structure under repeated low stress may be established within the next few years. This may be so, yet there are still conflicting statements that the origin of fatigue cracks is of molecular dimension, on the one hand, and atomic, on the other—which indicates they are not agreed as to whether the failure starts in the alloy or its constituents.

• **In the near future** the British Royal Aircraft Establishment hopes, by using the redundant Comet components, to establish a more precise relationship between the fatigue stress/-strain curve of a light alloy, as obtained from test specimens, and the behavior of that alloy in a fabricated item. Upon this work and the large-scale airline use of R. A. E. gust recorders, a fundamental "wear-and-tear" background for jet and turboprop airliners will be established. It is important to realize that as flight speeds and altitudes increase, so the stresses induced by air loads rise in proportion.

There is a rather belated trend toward integral machined structures in Europe. The delay has been largely caused by the shortage of suitable large-capacity machine tools, such as skin millers. Prior to the war, apart from some very fine Swiss machines, the European aircraft industry was mainly dependent upon Germany and the U.S. for all large and advanced equipment.

After the war, decimation of the German tool industry and shortage of dollars caused the aircraft plants to re-equip slowly. Priority was given to replacing worn plant equipment from the U.S. and only within the last five years has the monetary control eased to the point of buying large stretch presses—



**AIRCRAFT OF THE FUTURE as viewed by Sir Arnold Hall, head of Britain's Royal Aircraft Establishment since 1951, who joins Hawker Aircraft on November 1.**

and more recently forging presses and skin millers, etc. Most British and Continental airplane makers have experimented with integrally machined structures, but mainly on a small scale.

Ironically, the most advanced production structure was the ill-fated Swift, while Leduc has built the best integral wing—using an ordinary spar-cap miller. Meanwhile the military airplane is moving beyond the realm of light alloys and it is doubtful if civil production could afford the capital outlay—especially when there exist excellent substitute simplifiers and lighteners in Redux bonding, spot-welding and the use of the Franco-Swiss taper-rolled sheet for wing skins.

Regarding future aircraft, there is a clear division in the outlook between the civil and the military. The latter, while having differences with the U.S. and between national needs (e. g. French preoccupation with fighter-bombers and British interest in high-altitude penetration bombers), is bounded by the general overall NATO policy. In other words, the broad basis of future military airplane design is supra-national and is designed to counter what Military Intelligence has discovered about the threat from the East. The end-product, such as the Mach 2 interceptor, is fixed internationally, even if the method is national.

Civil aircraft development is strictly nationalistic in outlook and sometimes conflicting within a country but it appears to be settling down to something of the following order for the next decade:

• **Short ranges** up to 500 miles—The piston engine will continue with the lion's share among airplanes. About the end of this period the forty-seater helicopter may be in service in Europe for the 250-mile routes, but it and the airplanes will sooner or later be extinguished by the turboprop/jet-flap breed of city-center airplane.

• **Medium ranges,** up to 1,000 or 1,500 miles—Turboprop economy and relatively low altitude operation will tell. Again the jet flap, or at least super-circulation, will make good use of the present waste jet efflux at take-off and landing. Potentially, high-lift devices could mean shorter, slower, safer take-offs—in practice they probably indicate higher payloads.

• **Long ranges** will be served by turbojets, probably by-pass turbojets. Whether the economies of the slower turboprop will work out (utilization v. fuel consumption) to make it useful for tourist services is a debatable issue. The balance of BOAC opinion favors the two-type long-range fleet.

There is also the possibility that the supersonic, stub-wing, jet-lift, Atlantic airliner could pay its way on high utilization—but it is a generation rather than a decade away.

As far as guided missile development is concerned, the European security veil is so well closed that it is impossible to assess progress. It appears certain that no weapon has yet reached the stage of production and issue to the services of any air, ground or sea forces.

All-weather interception radar has been developed by its orginator, Great Britain, and is in service. There are, however, strong rumors that the latest electronic equipment for very high altitude work is suffering production delays—mainly on the governmental design and development side.

On the other hand, in France and England both private and state research into all-weather airfield control and airline operating equipment goes ahead—spurred on by Northern Europe's climate. Many, perhaps too many, types are going into production on limited service trials in the effort to achieve 100% airline reliability.

• **There is a tendency** in aviation today for there to be less than the safe time-lag between research and production. Drastic consequences have followed too-eager efforts to put novel information into practice—one can instance the chronic compressibility troubles of the last few years.

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tative results are obtained from basic investigations, which results are applied to design—leaving the unfortunate pilots and operators to find the quantitative answers by trial and error. Perhaps this is an appropriate point to pay tribute to German aerodynamic research of 1940-45; badly applied by its originators, but still much in evidence in current European (and U.S.) airplanes.

Europe, perhaps, suffers from many small, individualistic research establishments. The national and language frontiers make this inevitable, but even so there are further divisions within countries, so that there is nothing in Great Britain or France equivalent to the centralized, authoritative facilities of the U. S. National Advisory Committee for Aeronautics.

• **Inevitably, despite shortage** of finances and of scientific manpower, there is duplication where research comes under different control.

In the U. K., for instance, there is the R.A.E., the new National Aeronautical Establishment at Bedford, the National Physical Laboratory, the National Gas Turbine Establishment, as well as research centers for rocketry, radar, electronics, missiles, etc. On the other hand, it might be that such a revolutionary *aerodynamic* discovery as the jet flap would never have been thought possible by an engineer without deep knowledge of jet engine fundamentals. This is a good example; for the idea is so simple that it must many times have occurred to airplane designers, only to be dismissed as an idle fancy because of the mechanical difficulties and propulsive deficiencies of a slotted jet.

On the whole, the writer feels that the European set-up suits European characters and that a more stream-lined organization, though it might work more efficiently, would probably produce less original results.

• **Throughout Europe** there is a shortage of well-trained engineers and scientists. In the U. K. this is because of limited educational facilities caused by a shortage of science teachers. There has also been a raising of school-leaving age, plus two-year military conscription to delay entry of young men into industry.

First retirements of older technicians—the British aircraft industry is 40 years old—have, unfortunately, been concurrent with the hold-up of new arrivals. And upon both factors has been superimposed the increased complexity and "electrickery" of the post-war airplane. One would think the bottom of the curve had been passed and that it will steady up soon.

It is simply supply and demand—and usually it works out right. Three years ago electronic computers were unknown in European aircraft industries—there was a queue for the one or two government-operated "brains." Today, half the airplane companies in Britain have made their own and are even marketing them. True, these are analog instruments, and the digital machine is still pretty rare, but they seem to do their job—particularly with the critical flutter derivatives. Demand made supply—and at the same time helped to plug the shortage of technicians.

• **Undoubtedly a major deterrent** to recruiting in the European aircraft industry is the low pay offered. Right from the bottom to the top the technician's pay is far from commensurate with his learning, his responsibility, or the cost of the product. By contrast, the factory worker who makes the parts is well paid by industrial standards, often taking home more than the man who designed the piece he made.

Although highly industrialized, the European countries are much less mechanized than the U.S. This general fact applies to the aircraft industry also, although there are whispers of automation. Automatic production of small parts has, naturally, been under way for years, but there is now talk of electronically-controlled machining of major parts from computed design data. But one would say that for the next ten years there will be little change in production methods other than those required to meet the new materials.


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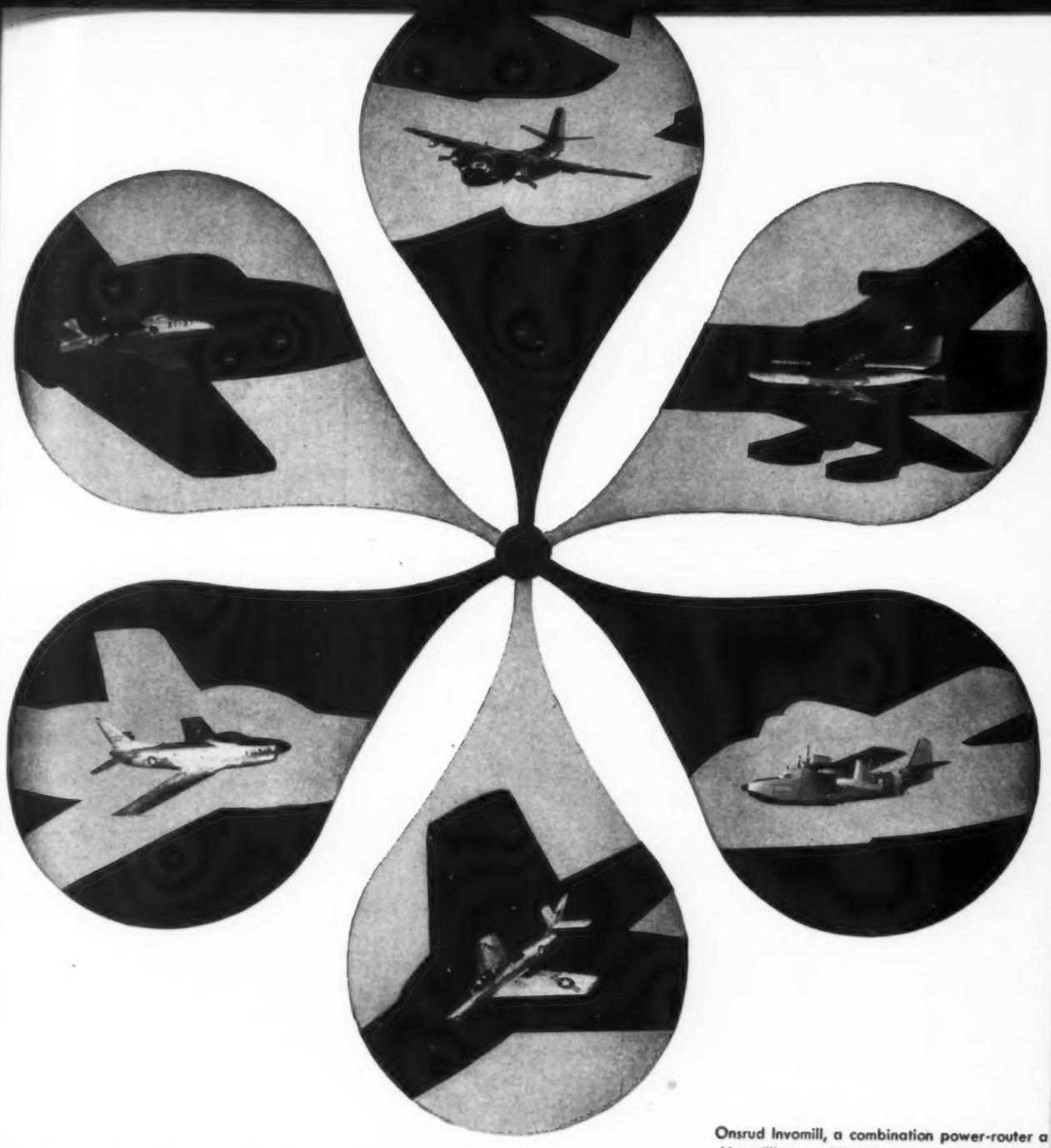

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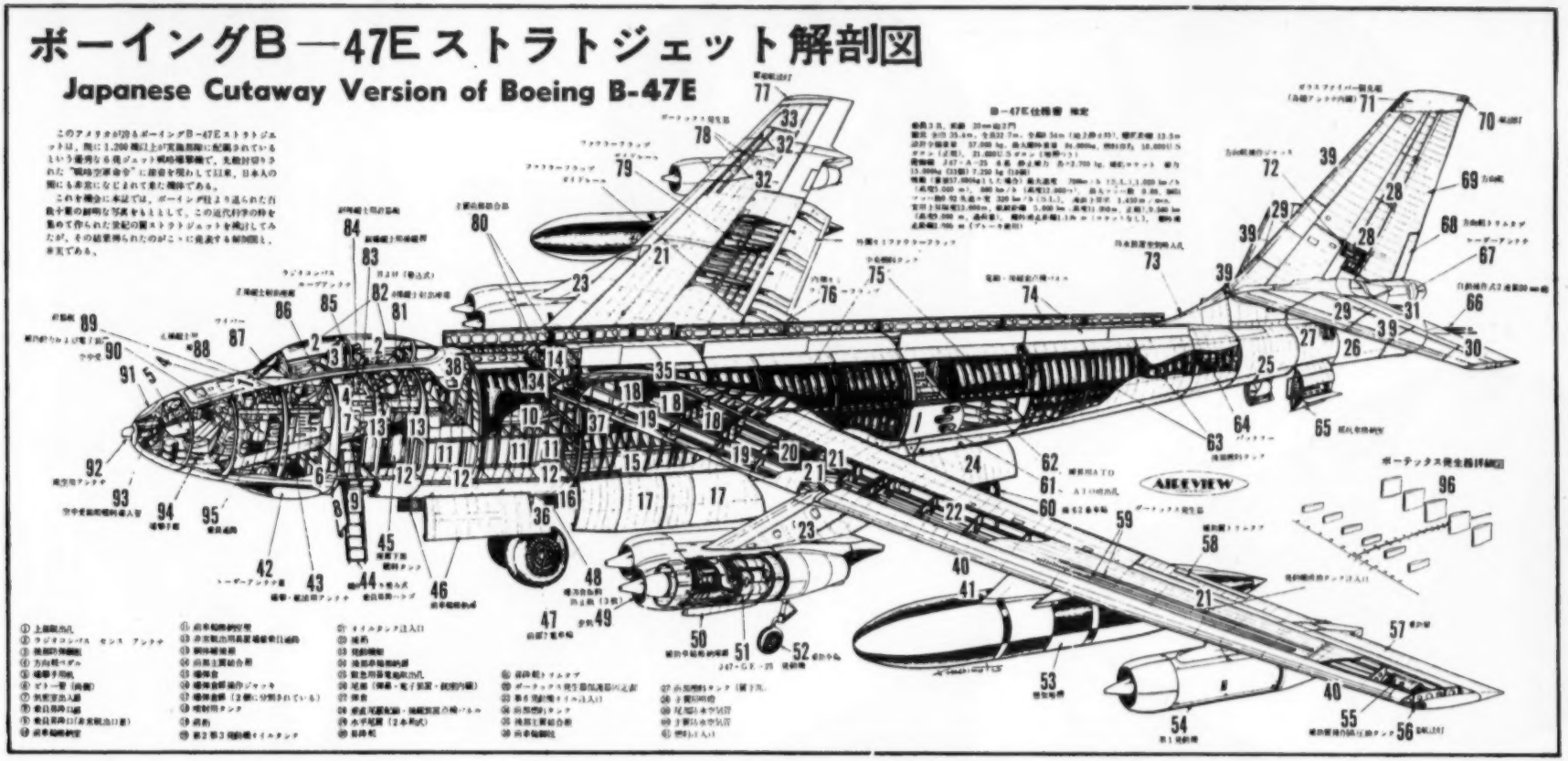
# ボーイングB—47Eストラトジェット解剖図

## Japanese Cutaway Version of Boeing B-47E



Key

1. Upper Escape Hatch
2. Radio-Compass Antenna
3. Rear Armor Plating
4. Rudder Pedal
5. Observer's Desk
6. Pitot Tube
7. Pressure Cabin Entrance Door
8. Entrance Door
9. Emergency Escape Hole (Entrance Hole)
10. Front Wheel Bay
11. Front Wheel Bay Wall
12. Cat Walk & Emergency Escape Equipment Stowage Place
13. Reinforced Frame
14. Front Spar Carry-Through
15. Bomb Bay
16. Bomb Bay Door Actuating Jack
17. Bomb Bay Door
18. Water Injection System Tank
19. Front Spar
20. No. 2 & No. 3 Engine Oil Tank
21. Oil Filler Cap
22. Rear Spar
23. Engine Pod Rack
24. Rear Wheel Door
25. Emergency Access to Batteries
26. Tail Cone
27. Magazine
28. Inspection Panel
29. Horizontal Stabilizer
30. Elevator
31. Elevator Tab
32. Vortex Generator Protector Wire
33. No. 6 Engine Oil Tank
34. Forward Fuel Tank
35. Rear Spar Carry-Through
36. Front Landing Gear Strut
37. Forward Fuel Tank
38. Wing Illuminating Light
39. Tail De-Icing Air Duct
40. Wing De-Icing Air Duct
41. Fuel Filler Cap
42. Radome
43. Bombing & Navigation Antenna
44. Built-in Ladder
45. Fuel Tank
46. Front Gear Door
47. Front Wheels
48. Belly Panel
49. Air Intake
50. Auxiliary Wheel Bay
51. J47 Engine
52. Auxiliary Wheel
53. External Fuel Tank
54. No. 1 Engine
55. Aileron Actuating Oil Tank
56. Navigation Light
57. Aileron
58. Aileron Trim Tab
59. Vortex Generator
60. JATO Exhaust Outlet
61. JATO Bottles
62. JATO Bottles
63. Rear Fuel Tanks
64. Batteries
65. Drag Chute Bay
66. Two Remotely-Controlled 20-mm Cannon
67. Radar Antenna
68. Rudder Trim Tab
69. Rudder
70. Navigation Light
71. Antenna Cover
72. Rudder Actuating Jack
73. De-icer Air Inlet
74. Inspection Panel
75. Fuel Tanks
76. Inner Flaps
77. Navigation Light
78. Vortex Generator
79. Flap Guide Rail
80. Front Spar Connecting Point
81. Co-pilot's Ejection Seat
82. Curtain
83. Co-pilot's Control Column
84. Co-pilot's Instrument Panel
85. Radio Compass Loop Antenna
86. Pilot's Ejection Seat
87. Windshield Wiper
88. Pilot's Control Column
89. Pilot's Instrument Panel
90. Servo & Electronics Equipment
91. Air Refueling Receptacle
92. Glide Path Antenna
93. Air Refueling Tube
94. Observer's Seat
95. Walk Way
96. Details of Vortex Generator

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*Industry's Top Engineers View*

# Aviation's Problems in the Supersonic Era

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**Engineering tomorrow's aircraft and missilesthrough the "thermal barrier" is a formidable task, such that top Air Force officials are now enlisting industry's total technical capacity in shaping its research and development toward one end—continued qualitative airpower superiority. For a first-hand view of these problems AMERICAN AVIATION has surveyed top engineers among U.S. aircraft, engine, missile and helicopter manufacturers, for their appraisal of the problems ahead. What these key engineers have to say, expressed here exactly in their own words, is truly a symposium on the shape of things to come.**

## *High Speed Complexity . . .*

**G. C. COVINGTON**
**Vice President-Airplane Engineering**
**McDonnell Aircraft Corp.**

Of our technical problems, the most important is how to combat the increasing complication of our aircraft that seems to go hand-in-hand with flight at increased speed and increased altitude.

Covington

The higher altitude flight carries us into temperature and pressure environments where many items of equipment, particularly electrical, cannot function satisfactorily except for brief periods.

Similarly, high speed flight is creating artificial environments of extremely high temperatures which adversely affect both the equipment and structural components of an aircraft. High speed flight also cuts sharply into the time intervals available to accomplish a given operation and, as a result, many new difficult dynamic problems are arising.

The increased dynamic pressures encountered in high-speed flight are requiring much greater power in all of the power-operated control systems of the aircraft. All of these items together are calling for a much greater use of power within the contours of the aircraft and the necessity for controlling this power by automatic means is only too often easily established.

We thus have controls upon controls, equipment necessary to enable other equipment to function properly, and we are rapidly approaching the point where it will be difficult, if not impossible, to maintain an aircraft on flight status unless some simplification can be accomplished.

We need to make equipment more rugged and dependable so that it will function under a much wider range of temperatures and pressures. We need to eliminate duplication of sub-components of equipment which is very prevalent in today's aircraft, and above all, we need to examine carefully the additional functions we are asking our aircraft to perform to see whether the additional utility gained thereby justifies the increased complication and reduced reliability resulting therefrom.

## *Less Complexity, More Reliability . . .*

**R. C. SEBOLD**
**Vice President-Engineering**
**Convair Division of General Dynamics Corp.**

The demands of modern weapons systems require us to advance on a broad front in engineering and science. There are no isolated problem areas which must be overcome to make progress. Our weapons are being propelled higher and faster and thus are creating an advanced breed of interrelated problems.

Sebold

As we increase speeds, we intensify our efforts in thermodynamics. How do we dissipate the heat developed by atmospheric friction? What materials do we use to withstand high temperatures and still maintain adequate strengths to support the aircraft structure? By what means do we effect aerodynamic stability and maneuverability at speeds many times faster than sound?

We are concerned not only with environmental problems in very high altitude, high-speed aircraft; there is the additional necessity to rely more and more on automatic electronic systems to supplement or even replace human judgment and human reaction. There are definite limitations on man's tolerance to an unnatural environment. Therefore we must provide a compatible environment for him or make the vehicle perform its function without a human passenger.

As we lean more heavily on automation, the complexity of the systems is multiplied, requiring a high order of reliability. Man's physical limitations in accomplishing tactical missions can be mitigated by handing over these tasks to guided missile systems, monitored from the ground —but only if limitations of materials are understood and overcome, if systems can be made less complicated, if performance can be made dependable.

The future is a challenge. We in industry are going

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to make progress, but we must:

- Blend engineering and science.
- Increase our knowledge of the environment in which our products must operate.
- Develop new and improved materials and techniques.
- Think in terms of weapon systems.
- Increase automation but without undue complexity.
- Develop facilities to simulate flight conditions on the ground.
- Do all this for a price we can afford.

## *Heat Energy to Power . . . ?*

**E. G. UHL**
**Vice President & Chief Engineer**
**The Glenn L. Martin Co.**

There are two technical problem areas resulting from the extension of speed and altitude performance of tomorrow's aircraft. I consider them problem areas because their solutions will not come from a particular technical field such as hydraulics, pneumatics, electronics, etc. but will require a combination of sciences.

Uhl

The first is the temperature problem associated with high speed. This is a tough one to handle because the condition becomes more difficult as performance increases. In other words, there will be no specific solution but the engineer will be required to worry constantly about heat just as he now has to worry about drag and stability.

The solution will be first attempted by brute force methods, i.e., designing structures to withstand high temperatures. Finally, however, the problem must be solved by finding new ways of transferring heat energy into sources of useful energy or into forms that can be dissipated into the airplane's environment.

The second major problem area is that of crew escape and survival. Designers will have to reach for new ideas to solve this problem. The ejection seat methods used in the past will be unsatisfactory when the next family of airplanes moves up in speed and altitude.

## *Cockpit Enclosures and Fluid Seals . . .*

**R. H. RICE**
**Vice President & Chief Engineer**
**North American Aviation, Inc.**

High speed jet fighter design problems are many and varied, but one of the most vexing is the problem of transparent material for windshields and enclosures for the pilot's pressurized cockpit.

Rice

There are many conditions of pressure and temperature which impose severe demands on the present windshield panels and canopy bubbles. The best available materials little more than do the job on current aircraft.

The best present known method of fabricating glass panels is to hot-press them together with vinyl and to retain them by an overhung edge of this soft material. The whole glass assembly must have structural integrity under a wide range of temperature and altitudes. The detailed means which have been developed to accomplish this have been evolved from many thousands of hours of laboriously testing various designs.

Optical qualities to meet the exacting demands of the Air Force are very difficult to obtain from the glass manufacturers, whose production methods are set up around automotive requirements. Moreover, great difficulty is encountered in making curved panels to the accurate dimensional tolerances required in aircraft design.

A Mach 2 airplane, under certain conditions, will have portions of transparent cockpit material undergoing temperatures in excess of 500° F, and at these temperatures no presently developed transparent materials are available to fulfill aircraft requirements.

The higher altitudes in which future aircraft must operate will require even higher cockpit differential pressures. The glass panels will also encounter a wider range of design temperatures.

## *Missiles and Cockpit Complexity*

**DR. W. L. BARROW**
**Vice-Pres. for Research & Development**
**Sperry Gyroscope Co.**

Again during the past 12 months, the greatest engineering problems at Sperry were concerned with all three areas of needed improvement in aviation equipment for manned aircraft, pilotless operations by the military, and fully operational aspects of guidance gear and flight controls for various guided missiles.

Barrow

Parallel progress in each of these challenging fields has been accelerated by solid achievements within the past year. From the standpoint of magnitude alone, perhaps the greatest task was the production and introduction into service use of the Sparrow I supersonic missile, the first air-to-air guided missile to reach such status.

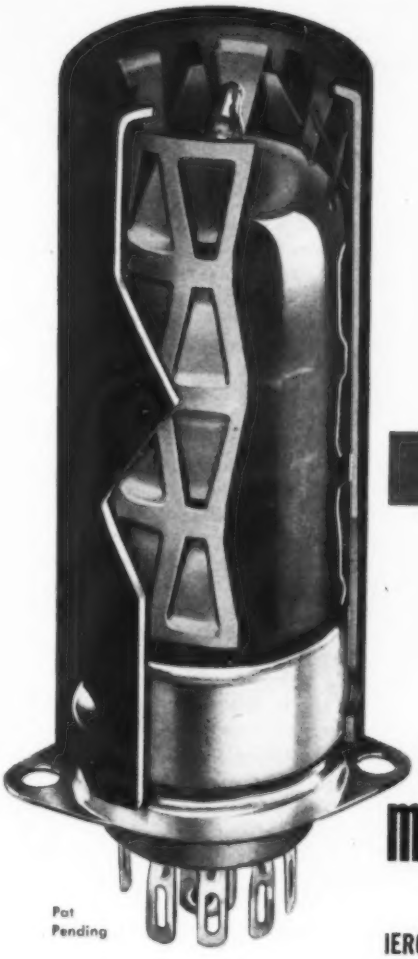
This demanded actual manufacture in quantity, or closest monitoring of other sources, of every element in such a new and complex weapons system. Also, it required that Sperry assist the Navy in some new and unprecedented preparatory work, including the development of special test equipment and the training of qualified personnel for reliable use of such a weapon.

At the same time, fully automatic flight controls and obedience systems for the Navy's Regulus missile, built by Chance Vought, were advanced by Sperry from engineering development to the production and training stage—ready for multiple missions, including not only flight test, but operational runway and launcher take-offs with repeated landings under accurate direction, and automatic tactical flights.

- **New engineering concepts** were brought to bear as well, on the acute problem of cockpit complexity in the kind of aircraft most of us ride in. Crowded instrument panels and cockpits have become a real problem to both engineers and pilots. Improved aids, to cope with the greater speeds and traffic hazards of modern aircraft, are required without adding to the pilot's burden of instruments to watch.

Reverting to the "basic six" instruments of a standard, simplified panel, Sperry engineers evolved the new Integrated Instrument System to combine needed information pictorially, in more quickly digestible form. This provides a needed flight director function, logically combined with associated gyro instruments, permitting the pilot to visualize his position more easily with respect to radio beams.

Equal progress has been scored in improvement of



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**electronic research corporation**
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There is an IERC heat-dissipating tube shield for every type of miniature, subminiature, octal and power tube.

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controls for pilotless drones under the system concept. Many years of experiment and flight testing now approach the payoff stage in actual production of reliable automatic controls and command guidance links for amazingly accurate control by "director" aircraft or remote stations on the ground. As might be expected, signal interference is a troublesome problem in this field, and much engineering effort has been devoted to various solutions with encouraging results.

• **Other immediate problems** presently looming in the foreground include a recognized need for longer range airborne radars; further improvement in reliability of missile control systems; steps toward automation of electronic component manufacture; wider application of semi-conductors and magnetic amplifier circuitry.

Current advances in the foregoing fields indicate two strong probabilities within the next decade:

(a) Increased automation of electronic "modules," and miniature transistorized circuitry will probably result in much cheaper, lighter and more reliable airborne electronics. Maintenance problems should be greatly reduced by the use of "throw-away" modular units.

(b) New navigation and guidance aids will permit accident-free flight operations in all weather under the high speed, heavy traffic conditions certain to develop within this period.

## *Need to Know—How?*

**HALL L. HIBBARD**
**Engineering Vice President**
**Lockheed Aircraft Corp.**

I think the outstanding problem confronting the aviation industry today is the need for "know-how" which will enable high-speed aircraft to cruise above the speed of sound.

Hibbard

Planes such as the Air Force's "century series" of jet fighters and interceptors will fly at speeds above Mach 1. But for how long? Only for a very short time, perhaps seven, eight or ten minutes. For the major part of their mission time—to and from the target area—they have cruising speeds in the subsonic range.

Actually, these aircraft are now achieving their bursts of supersonic speed mostly by relying on sheer brute force, drawing every last ounce of thrust from their engines.

• How do we go about producing planes which will cruise easily, economically and normally above the speed of sound for extended periods of time? The answer, most certainly, will be found in the research and development programs now under way in the many inter-related fields of high-altitude and high-speed flight. Every part of the airplane and its powerplant will have to be scrutinized and many changes will have to be made.

As an example of one of the "ifs" which could change the entire picture, if it were possible somehow to reduce the drag on present-day jet aircraft wings by 50 percent they could cruise at supersonic speeds. Of course, we're now building planes as "clean" and aerodynamically perfect as we know how, so further reduction of the drag poses a major challenge in itself.

Despite the lack of an answer to supersonic cruising at the present time, I am confident that within the next 10 years—by 1965—there will be a prototype transport flying which will be able to cruise at speeds well above Mach 1.

## *Many Unsolved Problems . . .*

**A. E. RAYMOND**
**Vice President-Engineering**
**Douglas Aircraft Co., Inc.**

Some of the unsolved problems the aircraft designers are plagued with today have been experienced in attempting to solve the overall problem of practical supersonic flight. The characteristics of the transonic and supersonic regions have become clearly defined because of the advanced state of theory and experiment: but much remains to be done in finding ways in which the unfavorable characteristics such as drag rise, separation, stability loss, etc., can be improved.

Raymond

A major problem in the structural field is that of developing stress analysis and design methods for aircraft structures subjected to high transient temperatures caused by aerodynamic heating. We must learn how to determine temperature distribution and its variation with time, the stresses caused by these temperatures and the deflection corresponding to these stresses. Some progress has been made in this area.

Another area where problems exist is in the equipment field. The quality of equipment remains a source of concern. Some equipment designs do not reflect the same degree of design development and rating as the airplane for which they are intended. Increased reliability, reduction of complexity and weight saving are essential.

There is a lag in the development of the equipment to meet new aircraft requirements. More work is needed in the fields of alternating electrical current systems, turbine powerplant equipment and pneumatic systems components for jet engine aircraft.

Also lagging in development are integrated systems for the generation and control of 115 volt, 400 cycle electrical power.

## *Component Development Lags . . . . . .*

**R. C. BLAYLOCK**
**Vice President-Engineering**
**Chance Vought Aircraft Inc.**

The development of aircraft and their power plants is progressing in a reasonably even balance for the present The development of components, however, especially autopilots, fuel controls, electronics, radar and fire controls, hydraulic pumps, valves and actuators is not keeping pace. Less than half of these components are capable of operating in the vibration spectrum and at the high temperatures encountered in modern high performance jet aircraft.

Blaylock

Much more research and development effort is needed to improve component reliability and increase over-all aircraft availability. We are devoting a tremendous effort to the design of "fail safe" power controls and stabilization systems in order to get reasonably trouble-free service. Powered and automatic flight control systems are essential in today's airplanes, and it takes very few failures at supersonic speeds to bring home convincingly the requirements for increased reliability of components of hydraulic, servo, electronic and electrical subsystems.

Much basic research remains to be done on pilot escape provisions at high speeds and altitudes. Test pilots are flying today at speeds and altitudes far beyond those

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for which an adequate escape system has been developed. This problem will be even more critical when today's experimental aircraft become operational service aircraft.

## *Steep Take-offs and Landings . . .*

**WALTER TYDON**
**Chief Engineer**
**Fairchild Aircraft—Div. of Fairchild Engine and Airplane Corp.**

The briefest consideration of nuclear warfare points up the urgent need for transport airplanes capable of operating from unprepared fields of a few acres extent. These airplanes must have the capability of very slow flight, with steep take-off and landing, but at the same time they should retain or surpass present transport cruise speeds. We propose high-performance, short take-off and landing (STOL) airplanes.

Tydon

The big technological problems in such airplanes arise, of course, from the take-off and landing. Several basic solutions appear possible. Only time and experience will tell which the future will employ. For the next several years a large amount of development work should be done following each approach.

Among the developments needed are the following: propellers having an improved level of thrust per horsepower at low speed; power plant types providing inherent interconnection of propellers across the span, or facilitating such interconnection; low specific weight, low-altitude turbojet engines for direct lift and control jet application; short-period thrust augmenters for turbojet engines; components, such as high output gas turbine compressors and high-pressure hot gas generators, for forced circulation systems; and high-flotation alighting gear of totally new concept.

While the development effort to date on wide speed range STOL airplanes has been minuscule in comparison with developments on other aircraft, it is not too early for construction to begin on man-carry research models of some types, at least of STOL airplane. Experimentation with these research airplanes will prove the best way to solve their most difficult problems: control at very low speed. It is not likely that conventional controls will suffice, for the performance desired, but means of producing control force independently of airspeed and of providing artificial stabilization, if needed, are now available. The industry should be encouraged to produce a number of STOL research airplanes in the next two or three years.

## *Structures and Cooling . . .*

**A. KARTVELI**
**Vice President-Engineering**
**Republic Aviation Corp.**

In the unprecedented range of speeds and altitudes for which advanced aircraft designs are now being studied, there are several major problem areas in which a large amount of development and research is still required to achieve successful performance.

Structural material is one of these problems. Due to the high temperatures developed by the compressed air over the surfaces of the airplanes, duralumin loses its strength and, therefore, becomes obsolete. This heat barrier has to be overcome by the use of materials such as titanium and special high strength steels for which no backlog of accumulated experience for aeronautical use exists.

New and novel methods of design, manufacture, processing and inspecting have to be developed. New techniques of testing structures at high temperatures are required. Vibration and fatigue properties must be established. Service experience must be gained. While intensive activities are in progress along these lines, considerable problem areas still exist.

Kartveli

• **Cooling of equipment,** and the intricate machinery and gadgetry of a military airplane is a problem area of equal importance. External heat is transmitted and added to the heat developed by the equipment proper. This heat must be diverted to assure correct functioning of the machinery. The problem is two-fold: evaluating the heat transfer and designing cooling equipment and ducting systems to assure satisfactory temperatures. Still much is to be learned in this problem area, both from the theoretical and practical points of view.

If the airplanes of the near future are to attain the envisioned speeds and altitudes, it is imperative that the problems of pilot's survival and comfort should be successfully solved. These comprise design problems of providing cabin supercharging, effective and functional controls, adequate vision, and, last but not least, safe pilot ejection in case of emergency.

Finally, a very old and malignant aeronautical problem is still with us, the problem of weight. The faster an airplane flies, the more weight is involved because of the requirement of stronger structure, larger engines, more fuel, more military equipment, etc. This is a really difficult problem area especially in the presence of ever growing military and safety requirements. In order to achieve performance, especially in regard to altitude, a minimum weight must be attained within a given volume.

Considerable progress has thus to be made in finding better structural materials, lighter equipment and accessories, more efficient engines and duels, more ingenious designs, better and more accurate manufacturing processes. These are complex problems involving cost, time, manpower, manufacturing technique, arguments with the management and government officials, etc.

## *Reliability and Complexity . . .*

**R. J. SANDSTROM**
**Vice President-Engineering**
**Bell Aircraft Corp.**

While the major engineering problems of today are often common to both guided missiles and manned aircraft, they are more clearly understood if regarded separately.

For that part of the aviation industry engaged in flight testing large supersonic missiles, reliability can be the greatest engineering problem. Most of this problem can be attributed to two factors. One, complex human nerve, brain and muscle functions had to be electro-mechanically duplicated. Secondly, missile designers under pressure had to take whatever component or subsystem they could obtain or quickly develop, and try to adapt it to a complex weapon system.

Sandstrom

In many cases, the only readily obtainable component had been intended for commercial use. The result has too often been complex, heavy, relatively unreliable hardware.

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Today Republic's famous Thunderjets and Thunderstreaks are in service throughout the free world. These planes, as well as the new RF-84F Thunderflash, form part of the striking arm of the air forces of the U.S. and other NATO countries. Soon to appear are the F-103 and F-105, while planes embodying advanced aerodynamic concepts are already in the mock-up and prototype stage. Still others are on Republic's drafting tables.

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*Address:*
**Mr. R. L. Bortner**
*Assistant Chief Engineer*

**REPUBLIC AVIATION**

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There are a variety of approaches for achieving greater reliability. One has been uniformity of manufacture of components specifically designed for a military job. To take care of this, a new industry called "avionics" has emerged and is showing significant progress.

The weapon system contractor can now use these components to their best advantage by systematic testing and critical statistical evaluation of a growing mass of data. With avionics groups, military customers and weapon system contractors having now gained enough missile experience to work together effectively, missile reliability is on the upgrade.

• **Other problems** with which a highly diversified aviation company must deal do not show such an orderly progression of solution. In the fields of advanced power plants and hypersonic research there appears to be a lack of a sense of urgency for rapid progress. In these areas, basic research and adequate testing facilities are lagging.

For example, vertical take-off and landing aircraft limitations are measured in terms of available turbojet power plants. There are proven solutions to the stability and low speed control problems.

In the case of hypersonic test facilities, it is more difficult to proceed in an orderly manner. Ideally, facilities should lead experimental vehicles. This probably would be the case were we always able to predict our progress. Since experience has shown we don't progress in a smooth slope, but rather in finite jumps, the synchronizing of facilities and test vehicles will probably never be complete. As an example, in the breaking of the sound barrier, the X-1 flew in supersonic flight before there were adequate supersonic wind tunnels.

• **In aerodynamics and structures,** performance capabilities have again expanded faster than design techniques and experimental facilities. With hypersonic flight technically feasible, we are facing a whole new set of design criteria. The effect of aerodynamic heating on such structural characteristics as flutter, tensile strength, fatigue, and local stress concentration previously could be virtually ignored. Each of these must now be treated as a temperature dependent variable.

Sufficient technical know-how exists to start the design of hypersonic vehicles which can achieve satellite velocity. Necessary development programs are being paced by the extension of present analytical abilities. We are now stretching the limit of paper engineering studies on materials, structural design and methods of testing. At this point, a more rapid expansion of laboratory and wind tunnel facilities is essential.

Aviation has come a long way in a short time. The major engineering problems of today are well recognized. But alongside the solution of these problems stands what often appears to be a large scrap pile. The faster the rate of solution, the larger the pile becomes, and the greater measure of courage is needed to proceed. We all must recognize, however, that keeping this rate above that of our enemies is a matter of survival.

## *Old Ideas—New Applications . . .*

**KARL ARNSTEIN**
**Vice President**
**Goodyear Aircraft Corp.**

A possible solution for present-day problems may be found in older ideas that have been discarded as being unsatisfactory. Experience has shown the engineer that ideas should be reviewed about every 20 years since many once found impractical later become significant advances.

In the automotive field the coil spring, replaced by the leaf spring, was later rediscovered as a great improvement after damping systems were provided. In aircraft landing gear development, the crosswind gear used in the first few years of powered flight was long neglected; then proved useful when applied to conventional systems; later seemed less necessary for tricycle systems, but is now again activated for the latest bicycle or tandem arrangement. Even the landing skid of early airplanes later became an acceptable gear for certain helicopter applications.

This process of re-evaluating old ideas in the light of new applications and engineering improvements should be encouraged since it provides the engineer with tools having history and background on which to build.

Two old ideas which might be re-examined are pressurized structures and use of fabric for aircraft construction. Pressurized fabric used in early and present-day airships has indicated that thin-walled structures, incapable of sustaining compressive loads, could provide remarkably lightweight rigid structures when pressurized. This idea of pressurization, applied to metal and plastic sections of modern high-altitude aircraft, might again save weight for the aircraft engineer.

Perhaps also the new synthetic and glass cloths, impregnated with plastic resins, could be applied with advantage in many selective applications but especially in expendable missiles.

Let us be careful not to discard ideas indiscriminately just because they were tried and found wanting once before. Today's techniques and conditions may be entirely different.

## *More Reliability Testing Needed . . .*

**FRANK W. FINK**
**Vice President and Chief Engineer**
**Ryan Aeronautical Company**

One of our major problems is the growing need for more reliability and environmental testing of the hydraulic, electronic, pneumatic and electromechanical equipment which we use.

Fink

By and large, the equipment manufacturers have done an excellent job in developing this specialized equipment and testing it. But the exceptions cause us the headaches, and they are on the increase because of the accelerated demands placed upon equipment.

Each new high speed aircraft or missile is precision-designed to deliver top performance in a specific environment. It represents a new combination of engineering skill and scientific knowledge. Similarly, the vital equipment used to service these aircraft must be especially designed to meet the exacting weight, size and complexity requirements imposed.

This means that less and less off-the-shelf equipment can be used. More and more, the equipment manufacturers must be prepared to meet special design requirements and provide reliability and environmental test information on their product.

• Typical areas are control systems and fuel systems for supersonic aircraft. It is not enough for the aircraft designer to know that this equipment will simply meet the major specifications outlined. He also needs to know the limits of performance and endurance of the equipment within certain environmental conditions.

This knowledge is necessary because of the advanced state of the art in which high speed aircraft and missiles are


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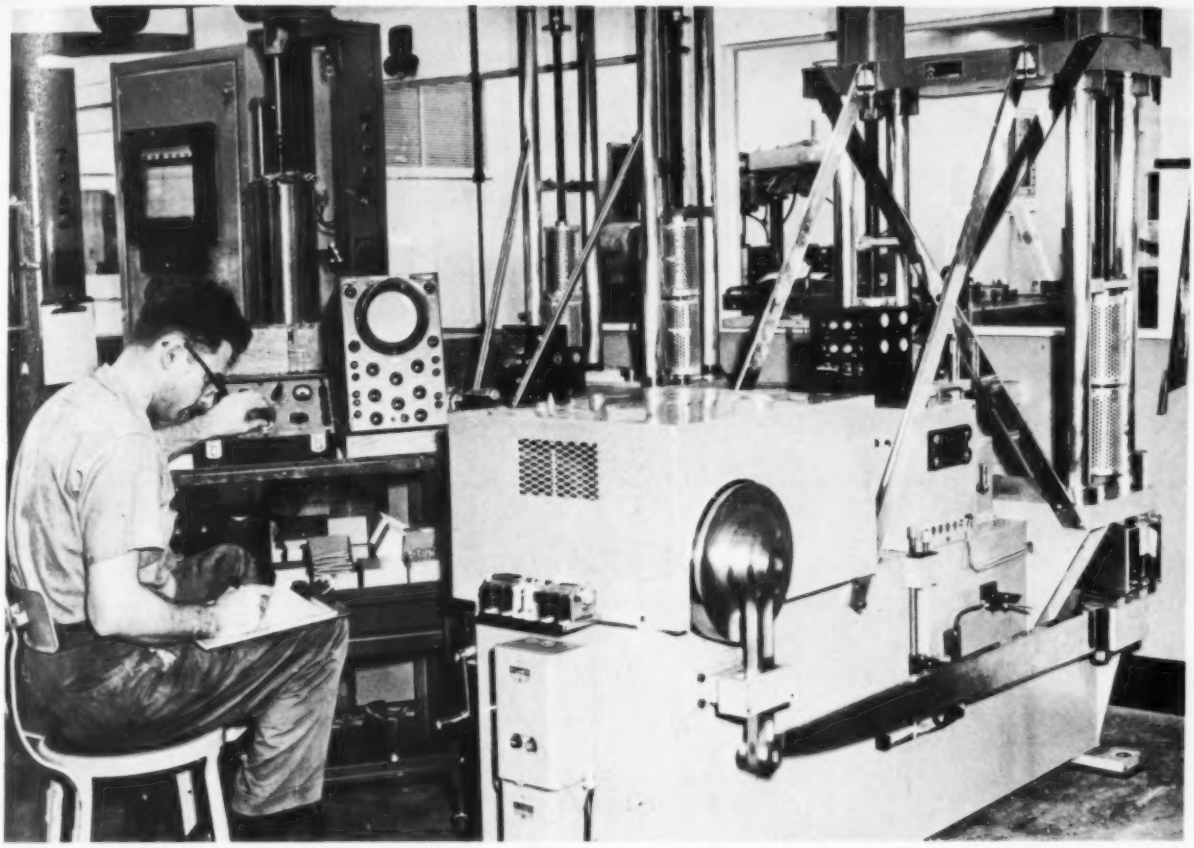

**CHARTING THE UNKNOWN.** The Fatigue Testing Center at SPS is considered by many aircraft authorities to be second in capacity for bolt testing only to the one maintained by the Air Force at Wright Field in Ohio. The cycle-stress graphs shown are the result of the first conclusive tension-tension fatigue tests ever made of titanium aircraft fasteners. To determine a single point on the fatigue curve—the endurance limit of a specimen—required almost 7 full days of test machine time.

# SPS RESEARCH PROGRAM DEVELOPS HI-TI TITANIUM AIRCRAFT BOLTS

### New Tension and Shear Bolts Equal or Excel Steel in Tension-Tension Characteristics

The successful application of titanium to tension and shear bolts is the result of 30 months' intensive research and development in the SPS plant. These new Hi-Ti Bolts are designed to replace present alloy steel bolts used in critical fastening jobs in aircraft applications. In tension-tension characteristics these bolts equal or excel alloy steel bolts of the same type. And since they weigh only 57% as much, one pound of them can do the work of just about 1¾ pounds of alloy steel bolts. Weight saving without loss of strength can range as high as 1000 pounds in a single plane.

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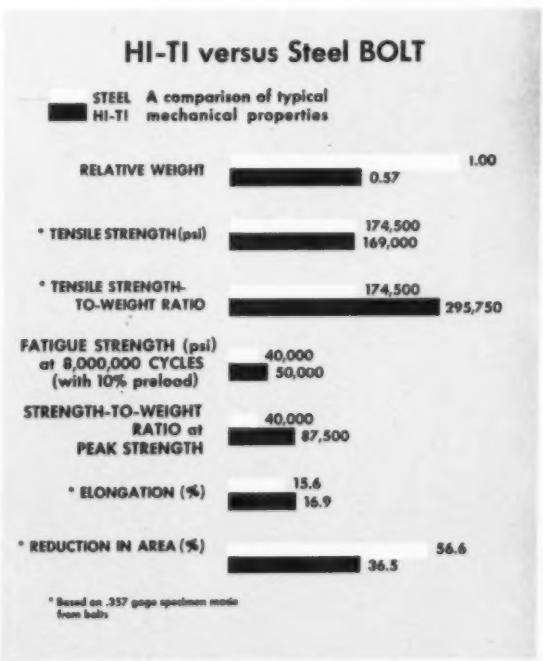
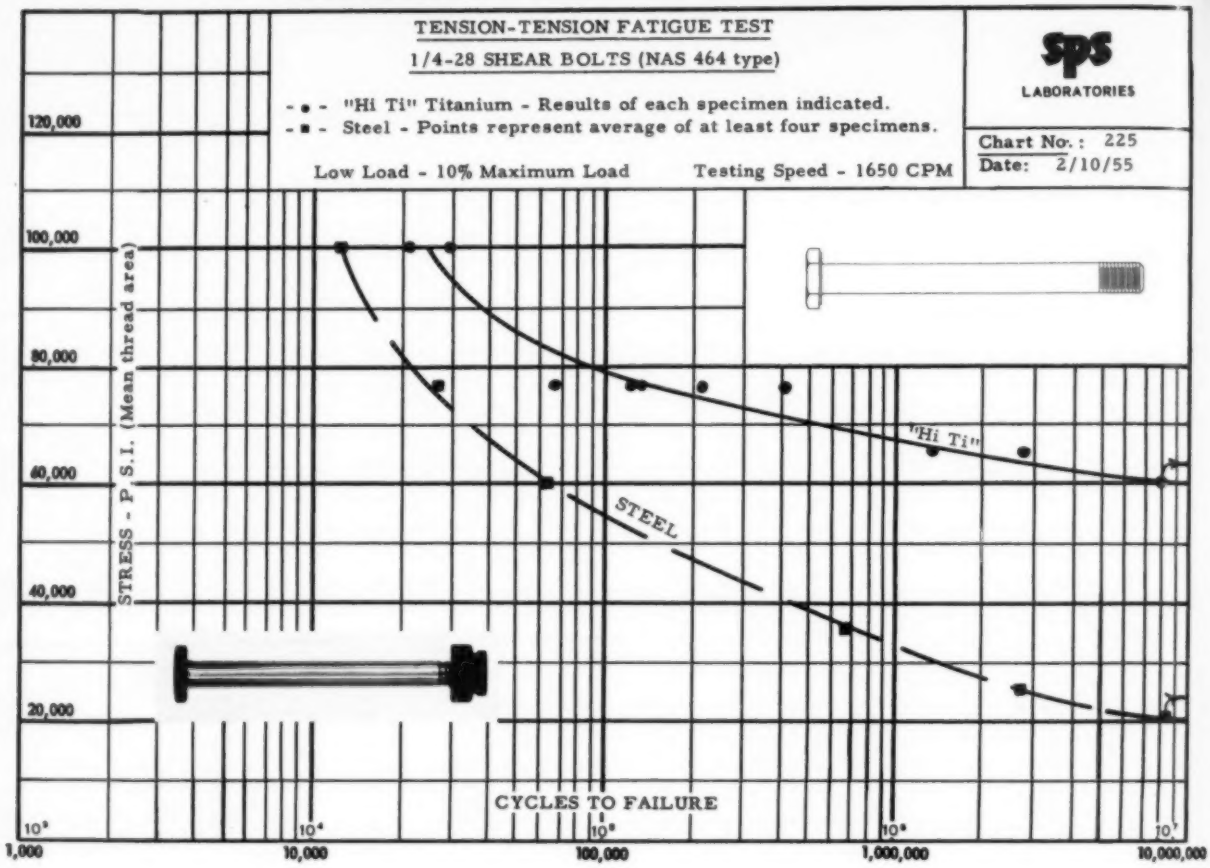
**AIRCRAFT PRODUCTS DIVISION** **SPS**

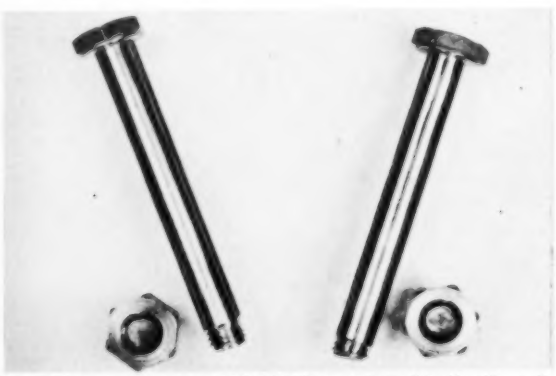



**Hi-Ti vs. Steel.** Tensile, elongation and reduction area properties are based on performance of bolt gage specimens. Endurance limit was determined by subjecting bolts to tension load alternating between maximum and 10% preload for a total of 8,000,000 cycles without inducing failure. Significant comparison is strength-to-weight ratio at endurance limit.

STANDARD PRESSED STEEL CO., Jenkintown, Pennsylvania



**1/4-28 NAS 464 Steel Shear Bolts** failed at the junction of the body and the head.



**1/4-28 Hi-Ti Titanium Bolts** (NAS 464 Type) failed in the threads near the nut bearing face, two to three full threads from the thread runout.

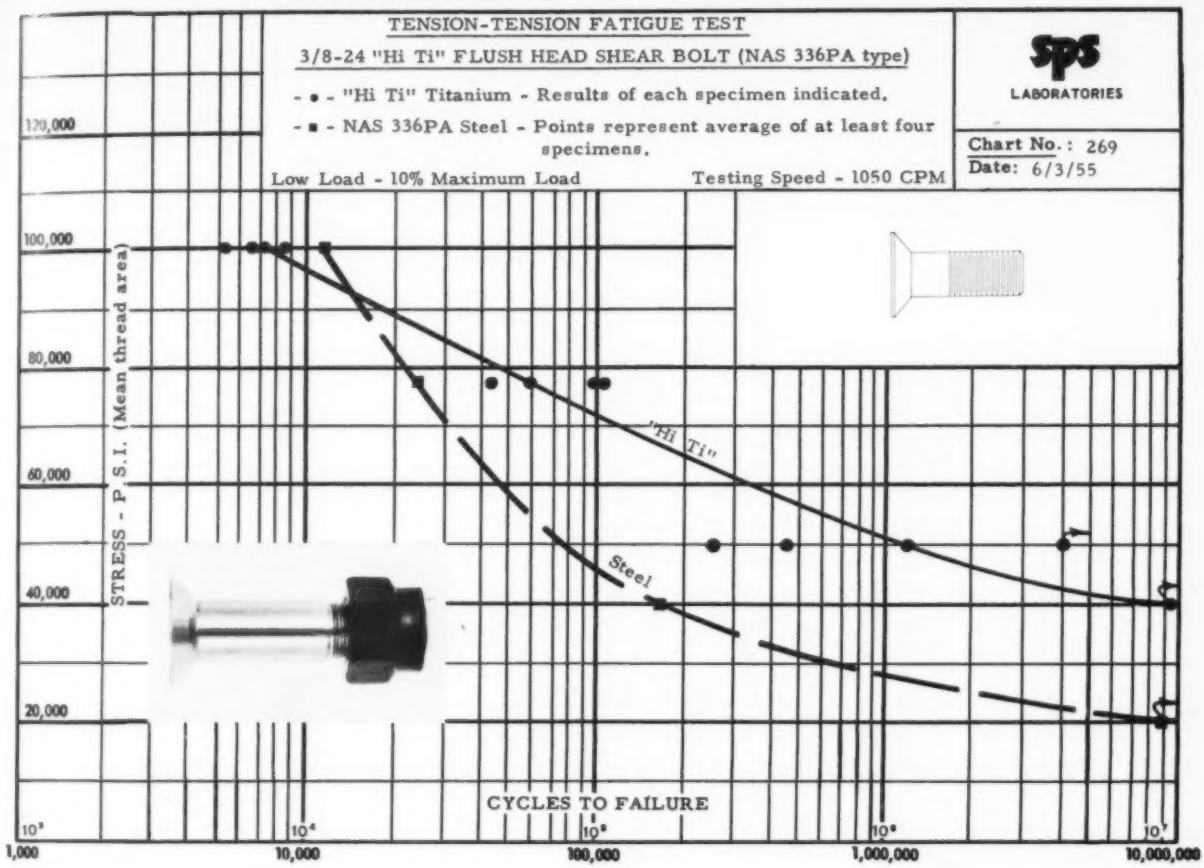
# A COMPARISON OF THE MECHANICAL PROPERTIES OF SHEAR BOLTS

## (NAS 464 Type)

| | ¼-28 DIAMETER | |
|---|---|---|
| | Steel AMS-6322 | "Hi Ti" Titanium (4A1-4Mn) |
| **TENSILE STRENGTH (psi)** | | |
| Root Thread Area | 223,100 | 193,200 |
| Mean Thread Area | 200,800 | 174,000 |
| Pitch Thread Area | 179,500 | 155,500 |
| .113 Gage Specimen | 179,450 | 155,000 |
| **YIELD STRENGTH (psi)** | | |
| Root Thread Area | 202,200 | 159,500 |
| Mean Thread Area | 182,100 | 143,600 |
| Pitch Thread Area | 162,800 | 128,400 |
| .113 Gage Specimen | 157,600 | 126,500 |
| **ELONGATION, % in 4 Dia.** | | |
| .113 Gage Specimen | 18.0 | 16.7 |
| **REDUCTION IN AREA, %** | | |
| .113 Gage Specimen | 54.5 | 41.3 |
| **SHEAR STRENGTH (psi)** | | |
| Bolt Body | 117,100 | 109,200 |
| **FATIGUE STRENGTH (psi) @ 8,000,000 CYCLES** | | |
| 10% Preload | 20,000 | 60,000 |
| **STRENGTH WEIGHT RATIO*** | | |
| Ultimate Strength | 179,450 | 271,250 |
| Endurance Limit | 20,000 | 105,000 |

* Using the density of steel as unity (density of steel 0.28 lb/cu in and of titanium 0.16 lb/cu in)

STANDARD PRESSED STEEL CO., Jenkintown, Pennsylvania



3/8-24 NAS 336P Steel 100° Flush Head Shear Bolts with Phillips recess which failed in fatigue tests.

3/8-24 Hi-Ti Titanium Flush Head Shear Bolts with Phillips recess which failed in fatigue tests.

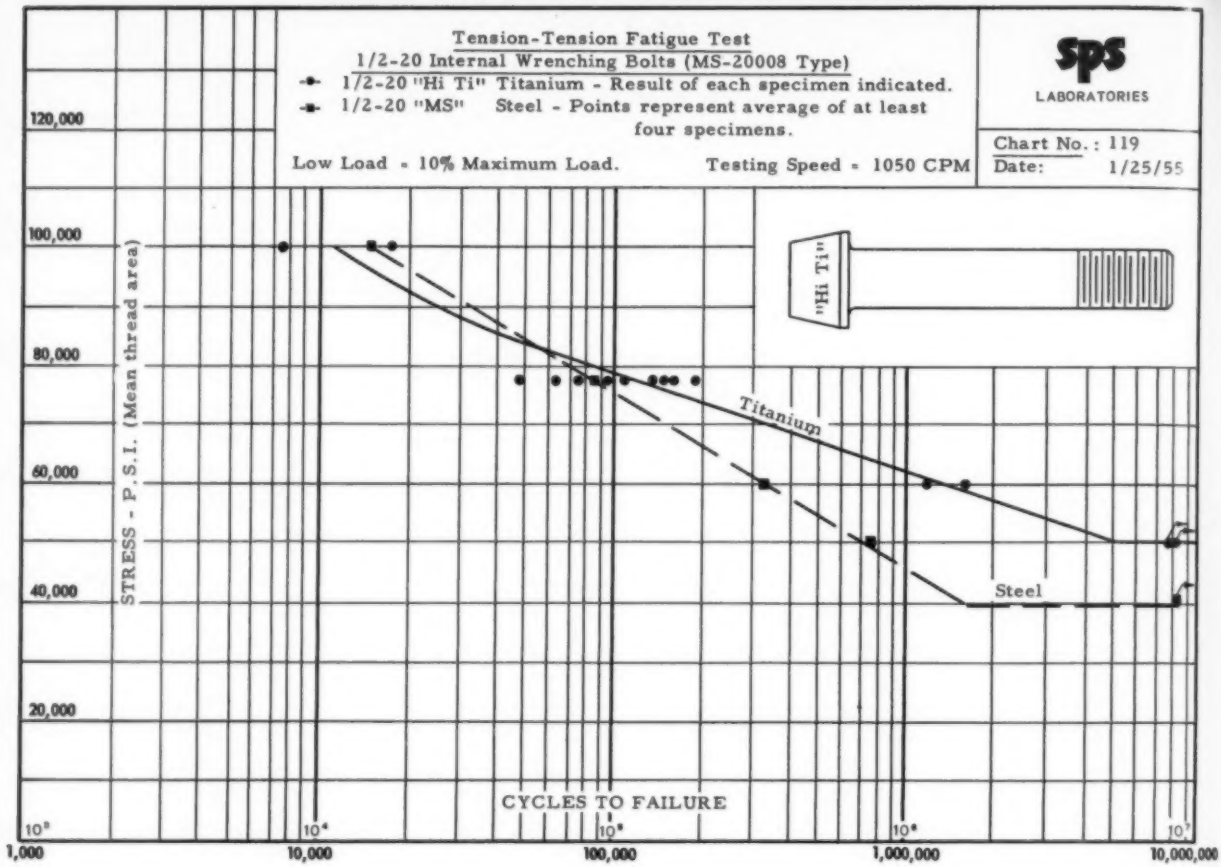
# A COMPARISON OF THE MECHANICAL PROPERTIES OF FLUSH HEAD SHEAR BOLTS

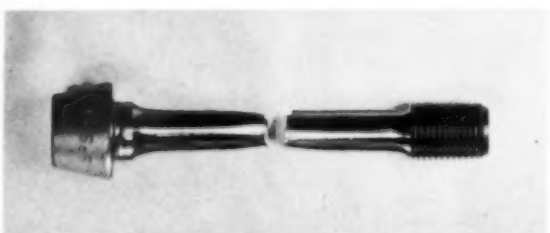
## (NAS-334 Type)

| | ⅜-24 DIAMETER | |
|---|---|---|
| | Steel AMS-6322 | "Hi Ti" Titanium (4A1-4Mn) |
| **TENSILE STRENGTH (psi)** | | |
| Root Thread Area | 202,720 | 195,920 |
| Mean Thread Area | 187,215 | 189,935 |
| Pitch Thread Area | 180,815 | 174,750 |
| .252 Gage Specimen | 178,355 | 164,330 |
| **YIELD STRENGTH (psi)** | | |
| Root Thread Area | 164,400 | 154,510 |
| Mean Thread Area | 151,825 | 142,695 |
| Pitch Thread Area | 146,640 | 137,820 |
| .252 Gage Specimen | 157,315 | 147,295 |
| **ELONGATION, % in 4 Dia.** | | |
| .252 Gage Specimen | 11.8 | 17.2 |
| **REDUCTION IN AREA, %** | | |
| .252 Gage Specimen | 49.6 | 33.7 |
| **SHEAR STRENGTH (psi)** | | |
| Bolt Body | 116,850 | 108,695 |
| **FATIGUE STRENGTH (psi) @ 8,000,000 CYCLES** | | |
| 10% Preload | 20,000 | 40,000 |
| **STRENGTH WEIGHT RATIO*** | | |
| Ultimate Strength | 178,355 | 287,575 |
| Shear Strength | 116,850 | 190,215 |
| Endurance Limit | 20,000 | 70,000 |

* Using the density of steel as unity (density of steel 0.28 lb/cu in and of titanium 0.16 lb/cu in)

STANDARD PRESSED STEEL CO., Jenkintown, Pennsylvania



**Failed .357 tensile specimen** machined from ½-20 Hi-Ti Titanium Internal Wrenching Bolt.

**1/2-20 Titanium Internal Wrenching Bolts** which failed in fatigue test. Note that all failures were located in the threads near the nut bearing face, three to four threads from the thread runout.

# A COMPARISON OF THE MECHANICAL PROPERTIES OF ½-20 DIAMETER INTERNAL WRENCHING BOLTS

## (MS20008 Type)

| | SPS M.S. Steel AMS-6322 | "Hi Ti" Titanium (4A1-4Mn) |
|---|---|---|
| **TENSILE STRENGTH (psi)** | | |
| Root Thread Area | 200,000 | 171,000 |
| Mean Thread Area | 187,500 | 159,000 |
| Pitch Thread Area | 174,000 | 147,850 |
| .357 Gage Specimen | 147,500 | 169,000 |
| **YIELD STRENGTH (psi)** | | |
| Root Thread Area | 183,500 | 162,000 |
| Mean Thread Area | 171,000 | 150,500 |
| Pitch Thread Area | 159,000 | 140,000 |
| .357 Gage Specimen | 162,000 | 153,000 |
| **ELONGATION, % in 4 Dia.** | | |
| .357 Gage Specimen | 15.6 | 16.9 |
| **REDUCTION IN AREA, %** | | |
| .357 Gage Specimen | 56.6 | 36.5 |
| **SHEAR STRENGTH (psi)** | | |
| Bolt Body | 110,000 | 103,750 |
| **FATIGUE STRENGTH (psi) @ 8,000,000 CYCLES** | | |
| 10% Preload | 40,000 | 50,000 |
| **STRENGTH WEIGHT RATIO*** | | |
| Ultimate Strength | 174,500 | 295,750 |
| Endurance Limit | 40,000 | 87,500 |

* Using the density of steel as unity (density of steel 0.28 lb/cu in and of titanium 0.16 lb/cu in)

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produced. The designer cannot anticipate all conditions under which the aircraft and its equipment may be called upon to perform. Therefore, he must know the limits of its performance.

Often, aircraft companies are forced to install special test facilities in order to get the data they need. In many cases this could and should be done by the equipment manufacturers because they are most familiar with their equipment and best fitted to provide the information.

## *Operations Research . . .*

**I. N. PALLEY**
**Vice President-Engineering**
**Temco Aircraft Corp.**

Research has been broadly categorized into pure (or basic) research and developmental (or applied) reesearch. Within the aircraft industry, we rarely engage in basic research, but developmental research is now being accomplished, especially in military applications, and its use is becoming increasingly important to provide the military organizations with detailed analytical data to select properly the weapon system to accomplish the designated mission.

Palley

Within the aircraft industry we call this activity operations research, and it is generally applied to many areas. The major function of operations research, and the one under discussion here, is the analysis of military requirements and the synthesis of a weapon to fulfill the requirement.

Two basic problems exist in operations research activity now being conducted in this country limiting its effectiveness in our national defense efforts. The first is that a large portion of this research is accomplished not in the aircraft or missile industry but in educational research institutions. This fact results in long communication lines for complex information transfer. Operations research physically located within the industry which will produce the resulting weapon system will minimize this problem. There is a trend in this direction now, but the industry must take initiative in building up these skills.

The second basic problem is the failure to utilize personnel in operations research work who have actual equipment and operational experience. The value of knowing the reliability of particular equipments and systems, of knowing the operational vagaries of systems, and of knowing the actual human-element contributions to tactical operations is unlimited in establishing requirements of weapons systems.

## *More Power for Small Planes . . .*

**WALTER C. JAMOUNEAU**
**Chief Engineer**
**Piper Aircraft Corp.**

The widespread adoption by business executives of small planes for personal travel has placed emphasis on operating characteristics which pose new problems for the designer.

Business flying is a scheduled type of operation, and as such, requires that the airplane be fitted with complete equipment to permit flying in comfort and safety in all types of weather. The equipment necessary to accomplish this objective adds considerable weight and in certain cases requires power for operation, thus indicating the need for more installed horsepower. Improvement in powerplant output and efficiency will be needed to make possible the increased performance and dependability demanded of planes used for business travel.

The trend to pressurization of passenger compartments, plural radio installations, devices to combat ice formation, and the powering of functional equipment all call for increases in power output. No doubt the engine builders will continue to develop other types of powerplant such as the turboprop and perhaps even the turbojet will become commercially available in the smaller categories, thereby making it possible for the designer to have a wide selection of powerplants from which to choose. Along with increases in power, aerodynamic refinement of the airplane will be accomplished to take advantage of the high performance the increased power will make possible.

## *Small Plane Safety . . .*

**TOM SALTER**
**Vice President & Chief Engineer**
**Cessna Aircraft Co.**

Of the three broad fields of business aircraft transportation—airline, executive and business flying—the safety record is very outstanding in the first two categories while that of the third is also outstanding but has not been too well documented.

Salter

Since this third category of businessman pilots is likely to involve less experienced people and faster airplanes in the future, it appears necessary that the safety record should be carefully studied.

In order to do this properly, we need a new yardstick of safety other than passenger miles. This passenger-mile yardstick was developed by the railroads at the turn of the century, specifically because it shows their record in the most favorable light.

In flying one gets a more realistic picture if he uses a vehicle-mile basis, especially when the average load is approximately two occupants to each airplane. After all, in an airplane, it is the vehicle that is exposed to the hazard by the occupants.

As a result, the small airplane as a method of transportation has one peculiar characteristic not comparable to other forms of transportation. This is the fact that the overwhelming percentage of hazards are the result of the decision of the occupants.

The automobile appears to have the same characteristics, but it is actually quite different due to the crowded highways and close proximity of other vehicles. This means, in effect, that your own safety is at least equally dependent on the person in the other automobile. Thus, flying by your own decisions in an uncrowded sky has very different basic safety implications.

Many businessman pilots fly their airplanes off airways and frequently make extended trips without seeing another airplane in the air. As a result, almost all hazards are known factors and are a part of the decision of the occupants of the airplane.

For this reason a businessman pilot has much more control over his destiny than in any other form of transportation, and as a result the statistics are beginning to show a very outstanding safety record.

However, it is a safety record that might be misleading and we, by no means, should rest on our laurels. We should aggressively sell safety and improve upon it in two directions.

The most fruitful direction for improving the safety

TOMORROW'S AIRCRAFT: *One step closer*

# Bull's-eye!

**In bomber defensive action** Westinghouse tail turret systems pay off in bull's-eyes . . . the only pay-off that is respected.

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Air Arm radar uses high-speed sequential lobing and high-performance servos, resulting in excellent tracking accuracy. Computer reliability is enhanced by the use of MAGAMP* magnetic amplifiers and potted units . . . all adding up to more than sufficient capability to down the fastest moving enemy aircraft.

**Since 1946,** Westinghouse has been developing, designing, testing, and *building* bomber defense systems, the latest features of which are still classified. Current production systems are being turned out in quantity for the armed forces, and on-schedule deliveries have been made for more than a year.

At the same time, parallel engineering development is constantly advancing the state of the art, working hand in hand with aircraft manufacturers and the military—to help you bring Tomorrow's Aircraft . . . One Step Closer. Westinghouse Electric Corp., Air Arm Division, Friendship International Airport, Baltimore 27, Md.

*Trade-Mark J-91026-B

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of business airplanes today is in building simpler, safer airplanes, and as a result, to provide the occupants more latitude in their decisions.

This first category would involve improvement of stalling and flying characteristics and simpler, more straightforward mechanical installation, such as that of engines and autopilots.

The other direction that we must go is to protect the businessman pilot better after something inadvertent has happened or after he has made a poor or unwise decision.

The second direction we must go then is to provide better things, such as shoulder harnesses, cabin structures, simpler communications, to be forgiving of deficiencies in judgment.

We are approaching a great new area of business transportation and we must keep our airplanes ahead of our pilots in safety. It is a great challenge.

## *Electronics, Instrumentation and High Speed Flight . . .*

**DIMITRIUS GERDAN**
**Director of Engineering**
**Allison Division**
**General Motors Corp.**

There is still a lack of reliability and durability in vacuum tubes, resistors, condensers, etc. which make up various electronic components and assemblies used in aircraft and on engines.

Gerdan

of recognition that, as applied to aviation requirements, this type of equipment must be designed to withstand higher temperatures, greater vibration forces and the rough handling of mechanics.

There is far too often a lack of good mechanical design in electronic There must be a complete break with the "radio and television set" design philosophy. There must be evidence and electrical components.

The use of electronic engine controls is too often discredited because of the mechanical design shortcomings of the electrical and electronic components making up such systems. The more complex current engines (and those of the future which will be still more complicated) may well need electronic controls if they are to operate at optimum conditions over a wide range of flight speeds and altitudes.

In aircraft/engine instrumentation, there must be a greatly accelerated effort toward the availability and use of adequate instruments in aircraft of all types for the indication of turbine engine rpm, gas temperatures and fuel flows.

Use of what are practically called "wrist-watch" dial sizes, wide pointers and "indicator" rather than the "instrument" approach to the design of these instruments far too often puts them in the category of the automobile clock as far as accuracy of reading is concerned.

Rpm indication errors coupled with temperature indication errors have far too often led to reduced engine life and to failures of turbine sections. Optimum cruise control, particularly in turboprop engines, can be obtained largely through sheer good fortune with some of the instruments that are used.

For high-speed flight, there must be intensification of the research and development attack on all the problems associated with flight speeds of turbine-engine-equipped aircraft in the Mach 2 to Mach 3 regime.

Equipment manufacturers who supply various components for aircraft and engines must raise their sights appreciably regarding elevated temperature operating characteristics of their equipment. Reliability and durability must be of a high order.

There should be intensified effort on the design and development of seals, sealing materials, gaskets, bearings, etc. to withstand operating temperatures in the area of 500°F and 1,000°F or higher.

Lubricating oils will have to operate at much higher temperature without serious breakdown if excessive oil-cooling requirements are to be avoided. Engine designers, in turn, will have to exercise more ingenuity to reduce heat rejection to the oil by reducing time of contact of the oil with parts not being lubricated.

Much has been said recently about aircraft inlet duct-gas turbine engine compatability. Many sad cases of incompatibility have occurred with the result that these "marriages" were terminated too often by engine failure.

Extension of flight speeds to the range mentioned earlier demands greater efforts on the part of the airframe designer to provide ducting with good pressure and velocity distribution characteristics. The engine designer, in turn, must recognize his part in this effort by determining and minimizing, as much as possible, the sensitivity of the engine to pressure and velocity variations at the compressor inlet.

## *Titanium in Turbojets . . .*

**ALLAN CHILTON**
**Chief Engineer**
**Aviation Gas Turbine Div.**
**Westinghouse Electric Corp.**

The greatest single problem area facing the aviation gas turbine designer and manufacturer is that of increasing the maximum operating temperatures of almost all the components of the engine to permit operation with maximum performance at the high ram temperatures associated with supersonic flight. At the same time reliability in service must not be sacrificed.

Our company has not been in large volume production on aviation gas turbine engines during the past year. We have, however, been very active in carrying on new research and development projects aimed at the subsequent production of improved aviation gas turbine engines. During this period we have made several significant advances in the art which we feel are major contributions to the solution of increased operating temperatures.

• We have successfully applied titanium and other high strength/density ratio materials to new engines. This has been accomplished by establishing optimum process control procedures for these materials which permit us to apply successfully titanium and its alloys to blades, discs, shafts, bolts and housings; and 17-7PH and 17/22 A (s) to complex sheet metal fabrications.

We have also successfully developed a high temperature paint and ways of applying this paint to low carbon steel to resist successfully high temperature operating conditions.

Significant advances have been made in the art of turbine coating. We have developed and successfully tested new gas turbines having turbine-blade cooling incorporated in the design. This will permit significant increases in turbine inlet temperatures.

• Another significant advance has been a substantial reduction of the "hot spots" in turbine engine combustors. Part of this advance was possible through close attention

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to details of design and manufacturing so as to eliminate or reduce to a minimum irregularities of air flow through and around the combustor. The other part was accomplished by more effective use of the air set aside for cooling the various combustor and turbine parts. This allowed a reduction in the amount of such air, approaching the turbine for the same power setting.

In the lubrication field, the Aviation Gas Turbine Division, with the cooperation of the Westinghouse Research Laboratories, has developed and successfully tested a modified silicone lubricant having the flat viscosity curve characteristic of silicone fluids, together with good lubricating ability and increased thermal stability throughout the operating temperature range of aviation gas turbines.

We have also successfully developed a carbon rubbing bearing seal which reduces air leakage through the bearing seal to a very small value to permit us to successfully incorporate a closed oil system in new engine designs. This minimizes the introduction of fresh air into the lubrication system and subsequent breakdown of the lubricant under high temperature as a result of the oxidation at the high operating temperatures that would otherwise take place.

The results of these advances will, of course, be reflected in improved performance of future aviation gas turbines to be developed for military and commercial market.

## *Materials Research Needed . . .*

**DON L. WALTER**
**Vice President-Engineering**
**Marquardt Aircraft Co.**

One of the major problem areas encountered as we fly at increasingly higher speeds is, of course, the "thermal barrier."

As manufacturers of ramjet powerplants, we find ourselves dependent upon free stream air as our principal and only simple cooling medium for our combustion chambers. Specifically, we can encounter combustion temperatures up to 4,000°F in our tailpipe, and the usual means of keeping the tailpipe cool is by exposing the other side to a high velocity stream of air at essentially stagnation temperature.

At Mach 4 flight speeds, the stagnation temperature of the air can be as high as 1,500°F. As the tailpipe temperature tends to fall about halfway between the hot and cold side gas temperatures, this implies tailpipe temperatures in the "outer" of 2,500°F.

This is beyond the capabilities of most materials presently considered for such use, and necessitates a vigorous research program to develop new and better high-temperature materials and/or cooling techniques.

## *Utility Aircraft Engines . . .*

**W. A. WISEMAN**
**Chief Engineer & Quality Director**
**Continental Motors Corp.**

The utility aircraft engine manufacturer must face squarely the challenge of the airplane manufacturer who demands the most horsepower per dollar spent.

This horsepower is usually requested in a package that has to be tailored to fit the specific requirements of an airplane or nacelle. This in itself, for an individual case, is not unusual.

However, when the combination of horsepower requirements are multiplied by the configurations for various aircraft, and then further multiplied by the changes resulting from the annual model trend, one wonders how the development and tooling costs could be anything but prohibitive.

Utility aircraft production, although expanding, is still relatively small, and the cost for changes in horsepower and design must be amortized over comparatively few engines.

What is our approach to this problem? It must lie in versatility of design and machining interchangeability.

Design versatility means that every engine must be so related to other engines in the family that horsepower and configuration changes can be accomplished with little effect on major components. Changes of this type include rearrangement of accessories, relocation of carburetor, addition of propeller gearing, addition of supercharging (including various locations for superchargers), addition of cooling fans, power take-offs, etc.

Machining interchangeability means that even though many detail changes are made that affect the functional duty of the engine considerably, the major components can still be processed over the basic tooling provided.

This is our contribution to making the utility aircraft industry economically possible and financially sound.

## *Controllable Power . . .*

**G. F. PEARSON**
**Chief Engineer, Engines**
**Jacobs Aircraft Engine Co.**

The future holds fascinating possibilities in aerial transportation to say nothing of interstellar travel, which has long been a dream, but now seems to have the possibility of accomplishment within the lifetime of many of us.

The only certain prediction that can be made is that progress will continue. Who knows what new force will be harnessed to power the aircraft of future generations? We can think of the possibilities of atomic energy, solar energy, power from cosmic rays or perhaps, some less spectacular engines using yet unknown fuels or power transmitted from sources on the ground.

• **The problem of safety** in aerial travel may be solved by electronic controls maintaining safe flight patterns, providing automatic controls on takeoff, in flight and on landing.

Meanwhile, we believe that piston engines will be with us for some years to come, particularly for private flying and for some military activities.

We, at Jacobs, have recently tested out a new concept in helicopter power plants. This is a package unit containing the engine with a clutch, reduction gear and rotor drive built in to the upper case. Our calculations indicate that this power package is approximately 20% lighter than comparable engine transmission and drive units of similar horsepower.

It has been installed and successfully demonstrated in the Jacobs Model 104 Convertiplane. This convertiplane offers a wide speed range with the safety features of being able to sustain hovering flight and to land without power through auto-rotation of the rotors.

## *On Helicopter Instruments . . .*

**GLIDDEN S. DOMAN**
**Vice President-Engineering**
**Doman Helicopters, Inc.**

I believe the instrument and equipment firms should take a new look at the matter of adapting existing flight instruments and navigation equipment to helicopters.

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For Mach 1 2 3 4 5 Temperatures...

3-position 4-way valve. 2-position 4-way and 3-way configurations also available. Ports can come out at any direction and solenoids can be positioned through 360° to give easily varied envelope configuration.

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This new pilot solenoid valve operates under ambient and fluid temperatures from −65° F to 600° F at 3000 PSI. *And* it will meet normal 160° F valve specifications for weight, leakage, pressure drop, flow rate and speed of operation. This high temperature valve is completely corrosion-resistant steel and has no rubber or synthetic seals to inspect or replace. Parker-precisioned spool and sleeve design maintains free operation even at 4000 PSI pressures. Because of these construction features, this control valve requires an absolute minimum of servicing and will normally perform for the life of the airplane.

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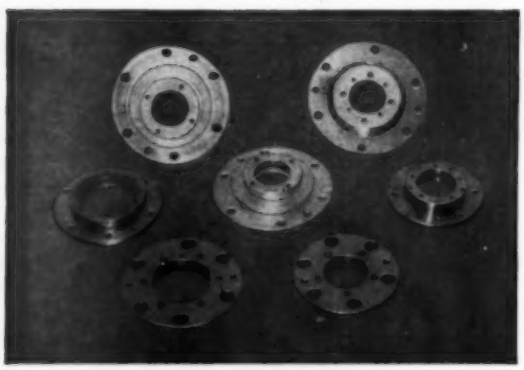

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Circle No. 29 on Reader Service Card.

mercial and military helicopters is logically required for the next great advance in their usefulness. When one considers the shortcomings of conventional flight instruments "adapted" to helicopters ten years or more ago, it becomes clear that much more could be done.

Mere application of presently advanced knowledge of contact piloting techniques and helicopter flight characteristics to improve function and presentation of airspeed, manifold pressure, etc. would pay off.

Settling upon a truly functional helicopter equivalent of the ball-bank indicator, covering the matter of rotor list, fuselage yaw vs. rotor yaw etc., would also contribute greatly to the ease of precise piloting.

Following up on these aids to contact flight, the matter of providing the intelligence for blind flight and presenting same in a form most useful and natural for the pilot would also be a great gain. It is probable that study of helicopter fuselage attitude and the factors affecting it would separate the useful from the useless intelligence, so that a true aid to piloting could be made available either blind or contact.

It is my belief that given a better knowledge of the how and why of helicopter flight, the instrument and equipment manufacturers could quickly arrive at variations of existing theory and equipment that would afford a great advance of helicopter utility, and that they could accomplish much of this on a "right now" basis.

## *Helicopters: Much to be learned . . .*

**LEE L. DOUGLAS**
**Vice President-Engineering**
**Piasecki Helicopter Corp.**

During the past year much has been learned of the helicopter's basic problems, such as stability, noise, vibration, de-icing and autopilots. Programs are under way to make further progress in these fields, but greater coordinated effort by the industry and government agencies will be needed in order to make further significant strides in the fields of navigation, stability, vibration and noise.

One problem about which more is to be learned is the cause of vibration in the transition speed regime from 15 to 30 knots that is found, to some degree, in all helicopters. A broad and fundamental research program is desired to achieve significant improvement.

Because of its extensive experience in the vertical takeoff aircraft field, the helicopter industry is particularly well qualified to make a significant contribution in the development of many new VTO applications.

New materials and processes are constantly being introduced in the helicopter industry to improve performance and reliability while at the same time reducing operating costs.

## *Helicopters and Servos . . .*

**BARTRAM KELLEY**
**Chief Engineer**
**Bell Aircraft Corp.—Texas Div.**

There are many problems in helicopter development which have been receiving intensive treatment from prime manufacturers and the accessory industry. These problems divide themselves into two categories. Some of them are basic responsibilities of the helicopter manufacturers themselves, and others are improvements in components such as oil coolers, pumps, bearings, etc.

Although the second category represents much effort

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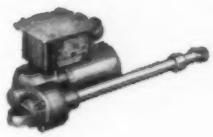

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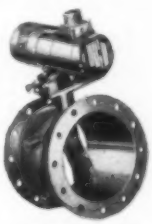

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and a steady improvement in the practical economic capabilities of the helicopter, this discussion will be confined to the two basic problems which seem to me to be of outsanding importance to the industry.

• **Rotor Simplicity**—All the large helicopters in practical service today in the United States use a servo control system. As helicopters grew large enough to carry significant payloads, the rotor feedback forces increased so much that hydraulic power cylinders became a necessity to provide acceptable control characteristics. When we consider that there are large transport fixed wing airplanes which can fly without such complications, we realize that the helicopter has lagged behind in this respect.

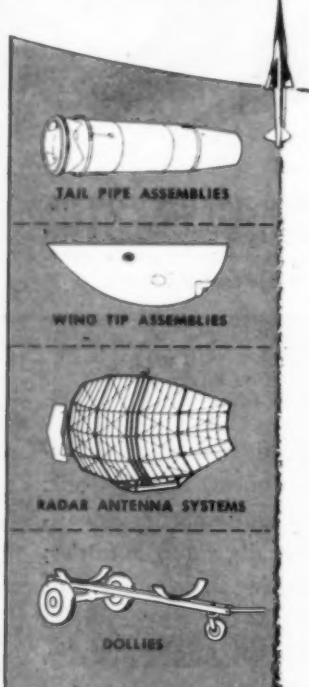
Some designers have used various forms of aerodynamic servos, but even these are more costly and complicated than the airplane trim tab. It is the responsibility of the rotor designers in the helicopter companies to attack this problem from the basic aerodynamic and dynamic point of view, and we have reason to believe that progress is now being made.

• **Blind Flying**—For several years now, helicopters have been flown on instruments in cruising flight. The solution to this aspect of the problem is well in hand. However, because of the helicopter's unique ability to fly very slowly and make extremely steep approaches, there is still much more work to be done.

If we consider all the implications of the problem of a blind cross-wind approach at 40 knots during a 20-knot wind, we have an illustration of one of the unique conditions. Just as helicopter flight patterns are different from those of the fixed wing airplane in VFR conditions, so are the procedures for landing, takeoff and general operation in poor visibility.

The only condition where the two types of aircraft are somewhat similar is that of cruising flight, a condition in which the helicopter finds itself for a relatively short percentage of flight time. The problem can be divided into two general parts, one being the actual physical techniques, and the other the presentation of information to the pilot. Both of these general areas are now being vigorously attacked by helicopter manufacturers as well as by the equipment industry. ◆◆◆


**PRODUCTION of COMPONENTS**
**for AIRCRAFT and GUIDED MISSILES**

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- in our planning
- in our methods
- in our shop

to handle low volume production and prototype development in complex and precision made sheet-metal and electro-mechanical assemblies. With its production know-how and adjusted management, GENERAL BRONZE CORPORATION is able to service your most exacting requirements . . . as a prime contractor to the U. S. Government . . . sub-contractor to such industry leaders as: Republic Aviation Corp., A. C. Sparkplug, Fairchild Guided Missiles, General Electric Co. and others . . . your inquiry is invited.

GENERAL BRONZE CORPORATION
STEWART AVENUE — AERO DIVISION — GARDEN CITY, N. Y.

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★**William B. McMahon,** Mooney Aircraft, Inc. Supt. of tooling and machine shop, Kerrville, Tex. (30 yrs.)

★**Art Mooney,** Mooney Aircraft, Inc. Supt. of production, Kerrville, Tex. (30 yrs.)

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**Charles L. Lundblad,** Trans World Airlines, Inc. Mgr. of construction, Kansas City, Mo.

**C. R. Cunningham,** Trans World Airlines, Inc. Supt. of communications, La Guardia Field, N. Y.

**J. A. Bearss,** Convair. Dept. 24-6, San Diego, Calif.

**Alex Sperber,** Sikorsky Aircraft Div. Factory mgr., Bridgeport, Conn.

**F. P. Schaefer,** Sikorsky Aircraft Div. Administrative engineer, Bridgeport, Conn.

**J. E. Johnson,** American Airlines. Lead ground serviceman, Amon Carter Field, Ft. Worth, Tex.

**H. W. Otto,** American Airlines. Senior sales representative, Chicago.

**V. A. Welsh,** American Airlines. Coordinator, Amon Carter Field, Ft. Worth, Tex.

**L. W. Harmon,** American Airlines. Supervisor ground equip.-maintenance, Tulsa, Okla.

**H. L. Whitmore,** American Airlines. Mgr. of operations, El Paso, Tex.

**H. Gallemore,** American Airlines. Mgr. facilities develop. and maintenance, Tulsa, Okla.

**O. H. Janzow,** American Airlines. Gen. foreman, maintenance, Los Angeles, Calif.

**J. A. Rae, Sr.,** American Airlines. Tooling specialist, Tulsa, Okla.

# CURTISS-WRIGHT TURBOPROP ENGINES and TURBOLECTRIC PROPELLERS power the BOEING XB-47D

## CURTISS-WRIGHT T49... MOST POWERFUL TURBOPROP ENGINE EVER TO FLY

The Boeing XB-47D is the latest in a series of operational aircraft which are providing the Air Force with vital logistical data.

In the XB-47D, two Curtiss-Wright T49 Turboprop engines—most powerful ever to fly—replace the usual four inboard jets, as the aircraft explores the range and speed potentials of turboprop power. And these T49's are equipped with another advanced development—Curtiss-Wright Turbolectric propellers.

This engine-propeller team is symbolic of the forward-thinking engineering and development program which has earned for Curtiss-Wright its leadership in world aviation.

**ENGINEERS • TECHNICIANS • SCIENTISTS**

**Curtiss-Wright has permanent career positions open for specialists in advanced engines and propellers, metallurgy, electronics, nucleonics, ultrasonics, plastics and chemistry. New 85 square-mile Research and Development Center at Quehanna, Pennsylvania and expanded divisional engineering programs are creating opportunities for more engineers, technicians and scientists in both aviation and diversified industrial projects.**

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CORPORATION • WOOD-RIDGE, N. J.

# CLIFTON PRECISION PRODUCTS CO., INC.

## Offers a full line of SYNCHROS

**FINEST QUALITY**
**HIGHEST ACCURACY size for size**
**TIGHTEST COUPLING size for size**

Size 8
.750" diameter
**ACTUAL SIZE**

Size 10
.937" diameter
**ACTUAL SIZE**

Size 11
1.062" diameter
**ACTUAL SIZE**

### SIZE 8
**Weight 32 grams**

| Function | Type Number | Excitation Voltage & Frequency | Output Voltage | Guaranteed Accuracy Spread | Remarks |
|---|---|---|---|---|---|
| Transmitter | CG-8-AS-1 | 26 Volts 400 c.p.s. | 11.8 Volts | 15′ | Transmitter for control circuits; not recommended for torque transmission |
| Control Transformer | CT-8-AS-1 | 11.8 Volts 400 c.p.s. | 23 Volts | 15′ | 3 or 4 will operate satisfactorily from CG-8-AS-1 transmitter |
| Resolver | CS-8-AS-1 | 11.8 Volts 400 c.p.s. | 21 Volts | 15′ | |
| Control Differential | CD-8-AS-1 | 11.8 Volts 400 c.p.s | 10.2 Volts | 15′ Stator 15′ Rotor | |

### SIZE 10
**Weight 50 grams**

| | | | | | |
|---|---|---|---|---|---|
| Transmitter | CG-10-AS-1 | 26 Volts 400 c.p.s. | 11.8 Volts | 12′ | High Power Transmitter; MIL-T-5350A; Multiple C.T. and Receiver Applications |
| Transmitter | CG-10-AS-7 | 26 Volts 400 c.p.s. | 11.8 Volts | 12′ | For C.T. Operation |
| Receiver | CR-10-AS-1 | 26 Volts 400 c.p.s. | 11.8 Volts | 30′ | Torque 2,400 mg-mm/degree with CG-10-AS-1 Transmitter; MIL-I-7057 |
| Control Transformer | CT-10-AS-1 | 11.8 Volts 400 c.p.s. | 23.0 Volts | 15′ | |
| Control Transformer | CT-10-AS-4 | 11.8 Volts 400 c.p.s. | 23.0 Volts | 15′ | High Impedance |
| Control Transformer | CT-10-AS-7 | 11.8 Volts 400 c.p.s. | 46.0 Volts | 15′ | High Sensitivity (Double Rotor Output) |
| Control Differential | CD-10-AS-1 | 11.8 Volts 400 c.p.s. | 10.8 Volts | 15′ Stator 10′ Rotor | |
| Resolver | CS-10-AS-1 | 11.8 Volts 400 c.p.s. | 21 Volts | 15′ | 2 Phase Rotor, 2 Phase Stator |
| Resolver | CW-10-AS-1 | 11.8 Volts 400 c.p.s. | 21 Volts | 15′ | 1 Phase Rotor, 2 Phase Stator |
| Sine-Cosine Generator | CV-10-AS-1 | 26 Volts 400 c.p.s. | 11.8 Volts | 15′ | 1 Phase Rotor, 2 Phase Stator |
| Linear Voltage Generator | LT-10-AS-1 | 26 Volts 400 c.p.s. | 10 Volts @ 60° | 15′ | Linearity to 65° better than 1% |

The units on these pages are standard with us and deliverable in *3 weeks or less.*

Synchros wound for other voltages and frequencies and with special shaft lengths and configurations are available on special order in production lots.

For full information and drawings on standard units or to discuss your special applications, write or phone:

*T. W. Shoop, Sales Manager, Phone (Phila.) MAdison 6-2101.*
*West Coast Rep., Wm. J. Enright, 988 Kensington Rd., Los Angeles. MUtual 6573.*
*Export Sales Inquiries: Andrew S. Szucs, Inc., 50 Broad St., New York 4, N.Y.*

EXTREME RELIABILITY

WIDEST VARIETY of standard types

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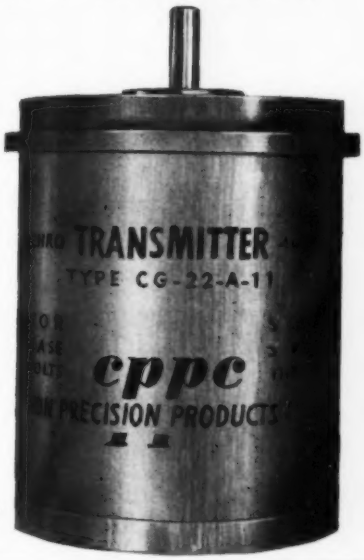
Size 15
1.437" diameter
**ACTUAL SIZE**

BuOrd Size 15
1.437" diameter
**ACTUAL SIZE**




Size 22
2.161" diameter
**ACTUAL SIZE**

## SIZE 11

**Weight 82 grams**

| Function | Type Number | Excitation Voltage & Frequency | Output Voltage | Guaranteed Accuracy Spread | Remarks |
|---|---|---|---|---|---|
| Transmitter | CG-11-B-2 | 26 Volts 400 c.p.s. | 11.8 Volts | 12′ | High Power Transmitter; MIL-T-5350A; Multiple C.T. and Receiver Applications |
| Transmitter | CG-11-B-7 | 26 Volts 400 c.p.s. | 11.8 Volts | 12′ | For C.T. Operation |
| Transmitter | CG-11-B-6 | 115 Volts 400 c.p.s. | 11.8 Volts | 12′ | High Level Excitation (Saves Transformers!) |
| Receiver | CR-11-B-2 | 26 Volts 400 c.p.s. | 11.8 Volts | 30′ | Torque 3,300 mg-mm/degree with CG-11-B-2 Transmitter; MIL-I-7057 |
| Control Transformer | CT-11-B-2 | 11.8 Volts 400 c.p.s. | 23 Volts | 12′ | |
| Control Transformer | CT-11-E-7 | 11.8 Volts 400 c.p.s. | 23 Volts | 12′ | High Impedance |
| Control Transformer | CT-11-D-6 | 11.8 Volts 400 c.p.s. | 57 Volts | 12′ | High Sensitivity (1 volt/degree) |
| Control Transformer | CT-11-B-8 | 11.8 Volts 400 c.p.s. | 22 Volts | 12′ | |
| Control Differential | CD-11-B-2 | 11.8 Volts 400 c.p.s. | 10.9 Volts | 10′ Rotor 12′ Stator | |
| Resolver | CS-11-B-2 | 12.6 Volts 400 c.p.s. | 22.6 Volts | 12′ | |
| Resolver | CS-11-B-5 | 22 Volts 400 c.p.s. | 22 Volts | 12′ | High Impedance |
| Resolver | CS-11-B-7 | 30 c.p.s. | 180 Mv. | 20′ | |
| Compensated Resolver | CY-11-B-2 | 22 Volts 400 c.p.s. | 25 Volts | 12′ | Includes two additional stator windings for feed-back compensation |

## SIZE 15

**Weight 126 grams**

| Function | Type Number | Excitation Voltage & Frequency | Output Voltage | Guaranteed Accuracy Spread | Remarks |
|---|---|---|---|---|---|
| Transmitter | CG-15-A-1 | 26 Volts 400 c.p.s. | 11.8 Volts | 10′ | High Power Transmitter; MIL-T-5350A; Multiple C.T. and Receiver Applications |
| Transmitter | CG-15-A-4 | 26 Volts 400 c.p.s. | 11.8 Volts | 10′ | For C.T. Operation |
| Receiver | CR-15-A-1 | 26 Volts 400 c.p.s. | 11.8 Volts | 30′ | Torque 3,300 mg-mm/degree with CG-15-A-4 Transmitter; MIL-I-7057 |
| Control Transformer | CT-15-A-1 | 11.8 Volts 400 c.p.s. | 22 Volts | 10′ | |
| Control Transformer | CT-15-A-4 | 11.8 Volts 400 c.p.s. | 22 Volts | 10′ | High Impedance |
| Control Transformer | CT-15-A-7 | 11.8 Volts 400 c.p.s. | 57 Volts | 10′ | High Sensitivity (1 volt/degree) |
| Control Differential | CD-15-A-1 | 11.8 Volts 400 c.p.s. | 10.8 Volts | 10′ Rotor 10′ Stator | |
| Resolver | CS-15-A-1 | 11.8 Volts 400 c.p.s. | 22 Volts | 10′ | |
| Resolver | CS-15-A-4 | 11.8 Volts 400 c.p.s. | 22 Volts | 10′ | High Impedance |
| Resolver | CW-15-A-1 | 15 Volts 400 c.p.s. | 28 Volts | 10′ | Very High Impedance |
| Transmitter | CG-15-MS-1 | 115 Volts 400 c.p.s. | 90 Volts | 10′ | MIL-S-16892; Gov't. Designation 15CX4a Weight 174 grams |

## SIZE 22

**Weight 528 grams**

| Function | Type Number | Excitation Voltage & Frequency | Output Voltage | Guaranteed Accuracy Spread | Remarks |
|---|---|---|---|---|---|
| Transmitter | CG-22-A-1 | 26.0 Volts 400 c.p.s. | 11.8 Volts | 10′ | Available for 60 c.p.s. use on Special Order. |

*LOOK TO CPPC FOR* cppc *SYNCHRO PROGRESS*

**CLIFTON PRECISION PRODUCTS COMPANY, INC.**

**CLIFTON HEIGHTS** **PENNSYLVANIA**

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# AIRCRAFT ACCESSORY PROGRESS—WHAT LIES AHEAD?

**Virtually no area of aeronautical engineering escapes the problems of high-speed flight. To get a picture of industry's progress of the past year, AMERICAN AVIATION surveyed a broad cross-section of top engineers among aviation suppliers for a first-hand report of recent developments and their immediate target for the future.**

## *Aircraft Systems*

**E. J. HORKEY**
**V. P., Chief Engineer**
**Pastushin Aviation Corp.**

During the past year, Pastushin Aviation Corp. has brought to the applied practical stage—in its production of F-86F force ejection pylons—the concept of force ejection which arose from the increased aerodynamic speeds and high loads affecting external aircraft stores.

The force ejection system developed by our company has successfully proved the safety and reliability of this method, and has been demonstrated under adverse conditions such as rolling, pull-outs and negative G force. Through experience we have developed an analytical system of determining the parameters of force ejection of a store and of predicting the expected separation trajectory in flight. This thereby reduces to a negligible factor the uncertainties of store ejection which worry the designer in the period between design and actual flight test.

• The immediate problem still to be successfully proved in force ejection is that of partial fuel remaining in an external fuel tank. Developments are now under way to overcome this by the proper application of a simple force in the proper direction at the precise instant needed.

• We believe that the applied science of force ejection will be reduced to simple applications and will be used in all phases of aircraft (whether commercial or military), guided missiles or space ships, wherever the separation of a bomb, tank, missile or even portions of the aircraft itself, is necessary.

**IRVING D. PRESS**
**V. P.-Engineering**
**Resistoflex Corp.**

During the past year, high temperature-high pressure flexible hose for —65°F to +400°F service was introduced to the industry. The specific prolems to be overcome, in addition to the old standbys of light weight and reliability, were resistance to 400°F temperatures and resistance to attack by synthetic hydraulic fluids.

The new hose represents a major breakthrough in connection with the problem of flexible plumbing for high temperature systems. Work on this development is now concentrated on perfecting design details and extending the range of sizes available.

The problem requiring the most immediate attention is that of seals for high temperature hydraulic systems.

**GRENVILLE B. ELLIS**
**Executive V. P.**
**Nickel Cadmium Battery Corp.**

Engine starting problems in the aircraft industry require extremely high ampere hour capacity per unit weight and space, along with non-spill factors and absolute reliability. The sintered-plate nickel cadmium battery, research and development for which has been done in this country by our company, has resulted in a high capacity battery ideally suited for aircraft starting applications over the extreme temperature ranges that are required. No other rechargeable system that we know of offers the advantages of the nickel cadmium system.

It is hard to compare the impact of this engineering achievement to other periods of time as there was no need for such a battery and such a battery did not exist. I think we can say that we have reduced to practicality a sintered-plate nickel cadmium battery that combines high current delivery, small unit weight and space, excellent reliability, superior discharge and charge characteristics, not only at high temperatures but at very low temperatures, along with excellent retention of charge characteristics and low maintenance requirements.

• At the present time the most challenging problems are those of standardization in a rapidly growing aviation industry and the use of as few sizes as practical for all the various aviation requirements.

• In a battery industry such as ours it is almost impossible to speculate on revolutionary contributions during a ten-year period because a battery is usually tailored to meet applications as they develop. It is quite conceivable that within the next ten years the nickel cadmium battery will be in common use, will be practically maintenance free, will have put into it the acme of reliability, and will supply characteristics of discharge and charge acceptance at all temperature rates that heretofore have not existed.

**GEORGE S. CHERNIAK**
**Director**
**Engineering & Development**
**Control Engineering Corp.**

Our most significant contribution has been the successful implementation of the philosophy which stresses the dual objectives of function and mass producibility during all phases of development and design. In the field of gyroscopic systems and components this has enabled Control Engineering Corp. to achieve major advances in satisfying extreme temperature and vibration requirements in minimal size, reliable and mass-producible designs.

Our most challenging immediate problem is the miniaturization of complex components for extreme environmental service conditions.

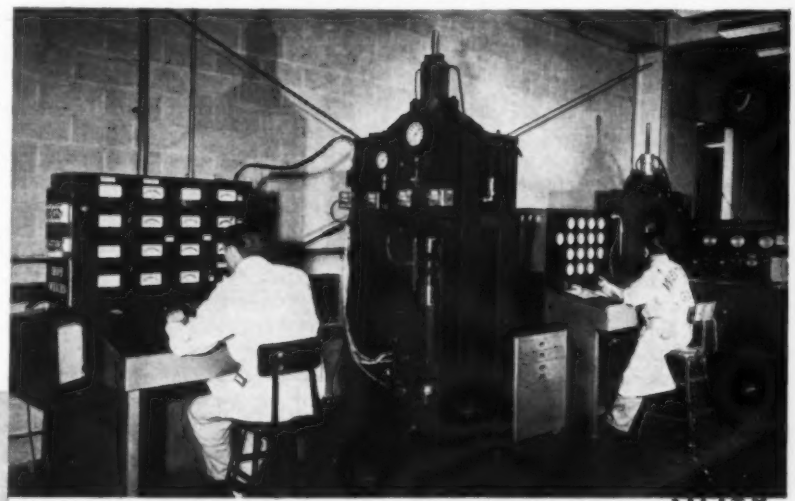
**EARLE M. SCOTT**
**President**
**Scott Aviation Corp.**

Scott Aviation Corp., has made significant contributions to the military, transport and business aircraft field during 1955. Further strides in 1956 are indicated.

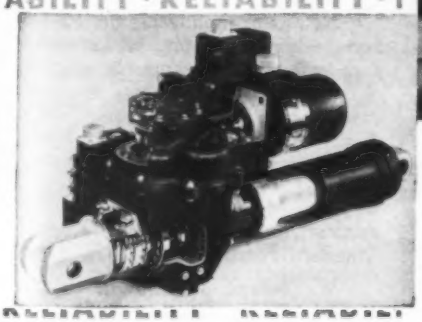
As a major supplier of aircraft

RELIABILITY · RELIABILITY · RELIABILITY · RELIABILITY · RELIABILITY

# The emphasis is on Reliability at WESTERN GEAR



*Expert laboratory technicians test stabilizer actuator for accuracy and operating characteristics using special Western Gear designed test stand which provides control instrumentation and automatic cycling.*



*Cutaway of Western Gear high load, dual motor, multi-speed aircraft stabilizer actuator. This unit is typical of a line of precision-engineered actuators capable of loads from 5,000 to 75,000 lbs.*

Continuous testing and inspection during all phases of production assure utmost reliability in every Western Gear aircraft gear drive component, whether single unit or complete system. Pride in workmanship plus four decades of aircraft industry experience in the manufacture of mechanical power transmission equipment add to certainty of reliable performance. So, to be sure of the best in design and construction, specify Western Gear. Detail your requirements for engineering recommendations. Address Executive Offices, Western Gear, P.O. Box 182, Lynwood, California.

*"The difference is reliability" • Since 1888*

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PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES



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"breathing" equipment, it faces tremendous challenges, among which are that equipment must be smaller ("miniaturized"), must be more comfortable and must be safer in spite of steadily increasing operational altitudes.

Tremendous gains have been achieved in these three aspects by Scott and its affiliate Firewel. Its Miniature Regulators are now accepted and in use. Its new Scottoramic Mask provides a maximum of comfort as well as safety for transport pilots. It has pleased and amazed the industry. Other comparably important developments are now being readied for production in all three fields of military, transport and business use.

**JOHN H. TROLL**
**Vice President for Engineering**
**Electronics Corporation of America**

I consider the most significant contribution made by us to the aircraft industry is the development of an explosion detection and extinguishing system. This system, located in the fuel tank and its cavities, detects the infrared radiation of an incipient explosion or the radiation output from an incendiary bullet, activates a counter-explosion, and extinguishes the explosion before the pressures generated by it become destructive. The system works under military aircraft specifications. No direct comparison between this and previous levels of achievement is possible here, since this is the first practical explosion extinguishing system in existence.

The most challenging problem is the further miniaturization and increase in reliability of electronic equipment to obtain life and operation characteristics similar to that obtained by mechanical equipment. Steps taken in this direction by Electronics Corporation are in the line of a solid state physics approach to the problem by creating components in which the inherent characteristics of matter produce the electronic effects rather than an assemblage of various components.

We are directing our efforts during the next 10 years to the elimination of human error in the operation of aircraft.

**R. H. SPELMAN**
**Technical Superintendent**
**Tire Department**
**General Tire & Rubber Co.**

We have developed a new line of small diameter, wide section (low profile) tires which successfully carry high loads at landing speeds in the 250 mph range. In the past, airplane tires were able to land and take off at fairly high speeds because loads decreased as speeds increased, the lift from the wings being greater at the higher velocities. Modern aircraft design minimizes this effect as the added drag would require increased lengths of runways to reach top speed. The tire problem has, therefore, become greater in that maximum load is on the tires right up to maximum takeoff or landing speed.

The new type tire that we have developed practically eliminates the so-called standing wave that occurs in conventional tires and permits the tire to be operated under these new, more drastic conditions. We believe that this advancement is a real forward step in airplane tire design. Since the dimensions and constructions require unorthodox methods, we believe that it is a distinct achievement.

The development of aircraft tires that will operate at elevated temperatures in the range of 400-500°F presents a real challenge to us. The supersonic speeds developing the high skin temperatures either require that we develop tires of this nature or that planes be provided with heavy air cooling equipment.

As in the past, we believe that tire companies will keep pace with the aircraft industry in providing tires to meet the more rigid requirements, such as will occur during the next 10 years.

**ROBERT J. BIBBERO**
**Chief Development Engineer**
**Hillyer Instrument Co., Inc.**

In the field of electronics and control systems, the most challenging problem facing the aviation and guided missiles industries is that of achieving reliable operation in the face of enormous systems complexity and revolutionary new components.

The problem is far from solved, but a tremendous mass of data on the performance of systems and components is being gathered (by such agencies as RETMA and ARINC, to mention only two), and both government and industry are cooperating to generate new data in many test facilities. The immediate need is the dissemination and interpretation of this material, so that it will be useful and used by the average design engineer.

• Within the next 10 years, electronic navigation and control systems, particularly those of a digital nature, will essentially take over the human piloting task, especially in military aviation. Systems complexity will increase by at least one order of magnitude. The principles of reliable design, a complete knowledge of component behavior in the environment and a thorough systems analysis will allow this increase in complexity without the penalty of failure.

**CHARLES K. BRUST**
**V. P.-Chief Engineer**
**Armament Components, Inc.**

These represent our new developments for 1955:

• Innovation of a system for storage and high-speed feeding, through a flexible conveyor of 20 mm and 30 mm ammunition and of 37 mm rocket missiles—without the use of ammunition links (Linkless Hi-Speed Feeder).

• Development of a system for insulation of flexible ammunition chuting —to 450°F ambient.

Most challenging of immediate problems is further development of adequate bomber defense missiles, plus the means for storing, feeding and launching of same.

New and improved aircraft armament systems will impose the need for and stimulate development of many changes and improvements in aircraft structures, airborne electronic systems during the next 10 years.

**JOSEPH P. VILLO**
**Division Manager**
**Aircraft & Allied Products**
**Standard Pressed Steel Co.**

We believe that the development of SPS "Hi Ti" titanium fasteners has been a very important contribution to the aircraft industry. We believe that these "Hi Ti" fasteners will enable aircraft engineers to design airframes in such a manner as to achieve a much lighter structure. We do not know of any other supplier of fasteners that has done a more complete titanium development.

We also have developed and manufacture high strength steel fasteners for the aircraft industry. These fasteners are in the 250,000 psi class. This has required many fatigue tests and the acquisition and development of new equipment to produce the high strength bolts.

We believe that the most impor-

# The *All-Metal* Multi-directional Mounting*

# ROBINSON originated and universally APPLIED

*This multi-directional mounting, when installed as recommended, protects equipment from imposed vibration and shock emanating from any angle and permits installation and use in any position.

**ROBINSON** Series 9300 plate type double acting multi-directional mount shown here in actual size No. 1, and available in any size required. Load ranges per mount:

Model 9301.....½-3 lbs. Model 9303.....2-7 lbs.
Model 9302.....1-6¼ lbs. Model 9304..Up to 15 lbs.

Natural frequencies 12-15 c.p.s.
Higher stiffnesses available.
Special designs upon request.

**1955**
**1954**
**1953**
**1952**
**1951**
**1950**
**1949**

**ORIGINATED BY ROBINSON** in 1949, the all-metal multi-directional mounting was designed to meet the radically new and different problems of ***guided missiles and jet aircraft*** requiring protection of electronic equipment from every angle against shock and vibration.

**ENGINEERED AND TESTED** in 1950, in the laboratory under rigorous specifications anticipating actual use, and in field tests far exceeding probable requirements, this mounting was quantity produced only when its performance had been demonstrated.

**SERVICE PROVED AND UNIVERSALLY APPLIED** since 1951, Robinson multi-directional mountings are now preferred for practically all military and commercial aircraft and in the newest of the guided missiles.

**RADICALLY DIFFERENT** from all other shock and vibration control mountings, this Robinson mount furnishes unique performance because of the inherently damped resilient cushions of patented Met-L-Flex, exclusively Robinson. No auxiliary damping means is required or used. Met-L-Flex is unaffected by attitude, extremes of temperature, aging, or the presence of oil, dust or dirt.

**WHEREVER UNFAILING PERFORMANCE** of equipment under maximum environmental difficulties is required, ***only Robinson*** multi-directional mountings will meet the difficulties involved.

If your need is for complete multi-directional protection of airborne electronic equipment and the assurance of its optimum performance, call on Robinson.

SEND FOR BOOKLET No. 900 "A New Concept in Vibration and Shock Control for Airborne Electronic Equipment."

**ROBINSON AVIATION INC.**
TETERBORO, NEW JERSEY
*Vibration Control Engineers*
AIRBORNE DIVISION

**WEST COAST ENGINEERING OFFICE**—Complete engineering design and test service. 3006 Wilshire Blvd., Santa Monica, California.

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tant challenge in the aircraft industry is the development of high strength fasteners that will withstand temperatures of 1,000°F. This project is being worked on in SPS laboratories and we are looking forward to an early solution of this project.

We feel that within the next 10 years SPS will develop fasteners that will cope with any strength requirement, as well as temperatures. That definitely will be a requirement with the present aircraft program, which requires faster speeds. SPS Company and its unlimited laboratory facilities plus its staff of trained engineers will be in a position to develop and manufacture these special fasteners.

**DAVID R. TASHJIAN**
**Engineering Manager**
**Electronics Div.**
**Westinghouse Electric Corp.**

The successful direction and control of aircraft, whether manned or pilotless, civilian or military, are dependent upon our ability to communicate with those aircraft. Increasing complexity of function and numbers of aircraft place a severe challenge before the communications designer to provide adequate intelligence within the available frequency spectrum.

**WILLIAM A. KEETCH**
**V. P.-Engineering**
**Robinson Aviation, Inc.**

In recent months it has become increasingly apparent that a new philosophy is required in the concept of vibration and shock isolation systems for airborne vehicles. Design objectives and, in fact, actual vehicles already exist whose requirements for vibration and shock protection greatly exceed all existing military specifications for isolators. High vehicle performance coupled with the fact that reliability is almost wholly dependent upon equipment function rather than a human pilot has made it essential that this problem receive detailed attention.

Robinson Aviation, Inc. was founded on the thought that the best solution to a vibration or shock isolation problem is an engineered mounting system tailored to fit the specific equipment in the environment to which it will be subjected. Thus, unhampered by the necessity to employ "catalogue isolators" or obsolete specifications, we have successfully developed mounting systems to meet these new conditions.

All metal construction, pioneered by Robinson and using Met-L-Flex knitted, stainless-steel wire-resilient elements, completely eliminates most problems of temperature, age, humidity or chemical deterioration. Freedom of

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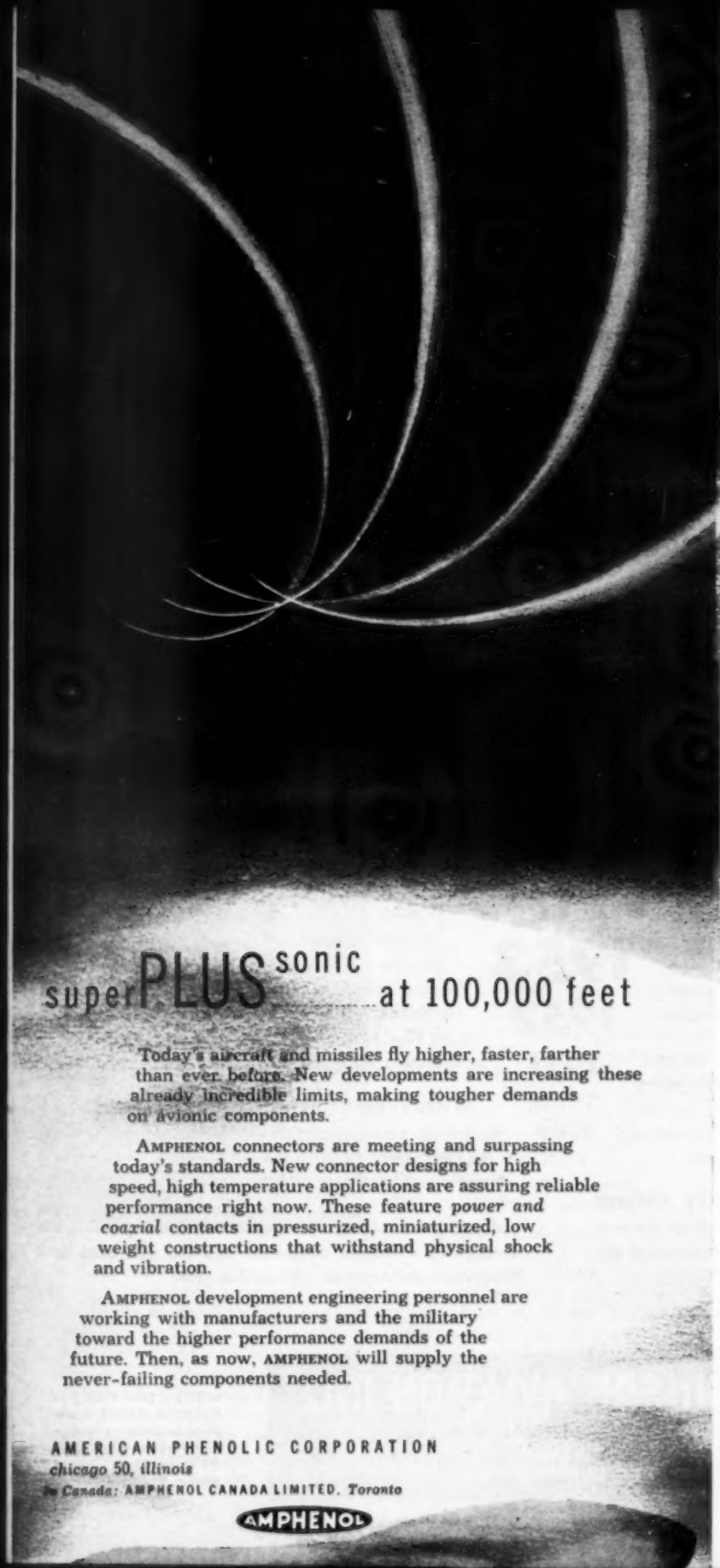
super PLUS sonic
at 100,000 feet
Today's aircraft and missiles fly higher, faster, farther than ever before. New developments are increasing these already incredible limits, making tougher demands on avionic components.
AMPHENOL connectors are meeting and surpassing today's standards. New connector designs for high speed, high temperature applications are assuring reliable performance right now. These feature power and coaxial contacts in pressurized, miniaturized, low weight constructions that withstand physical shock and vibration.
AMPHENOL development engineering personnel are working with manufacturers and the military toward the higher performance demands of the future. Then, as now, AMPHENOL will supply the never-failing components needed.
AMERICAN PHENOLIC CORPORATION
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# controlled performance

by Reeves INSTRUMENT CORPORATION

**DAY OR NIGHT — FAIR WEATHER OR FOUL** . . . whether the target is an airfield . . . railroad bridge . . . factory area . . . ammunition dump . . . shipyard or troop concentration, Reeves ground guidance systems provide the Air Force with an offensive threat capable of hitting the bullseye every time — sight unseen. Tested during the Korean war, the control equipment illustrated below is the tactical unit developed and produced by Reeves on which the U.S. Air Force depends . . . both at home and abroad. This completely automatic guidance control is capable of directing any type of missile or airplane, either with or without pilot.

Reeves has a thoroughly trained engineering group available at all times to help you solve any guidance problem. In addition to Command Guidance Systems, Reeves has a wide experience with all three Services in the development of Radar, Gun Fire Control, Servo Mechanisms, and Computing Systems of all kinds. Their extensive facilities are available for all types of prime or sub-contract operations

Reeves INSTRUMENT CORPORATION

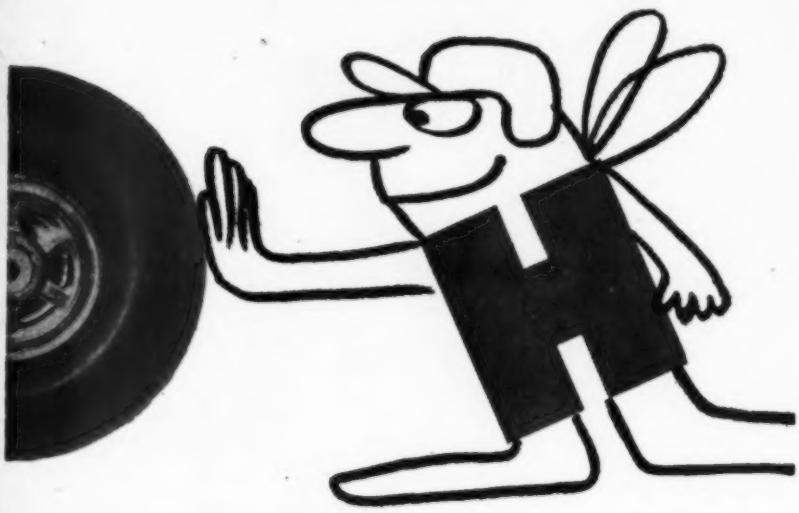
Reeves Command Guidance Systems

**REEVES INSTRUMENT CORPORATION**

A Subsidiary of Dynamics Corporation of America

215 East 91st St., New York 28, N.Y.

# *Meet Hy Trol...*



## *all-weather friend to pilots*

Hytrol, Hydro-Aire's Anti Skid Braking System is not only a staunch friend for a pilot to have during any landing under tough conditions. It is a valuable standby to augment pilot control during landing runs under *any* conditions.

Hytrol gives the pilot power to reduce roll in rain, snow or ice to within 50 feet of required distance for dry conditions (C.A.A. tests). In addition, Hytrol is an obedient servant *always:* to keep landings straight and smooth; to get rid of lots of knots mighty quick and if you have to; and to cut down tire and brake maintenance.

Actually, you'll find Hy Trol a heck of a nice little guy to have around!

***hytrol*** is Standard Equipment on: B-47, B-52, A3D, B-66, RF-84, F-100. Installations on: DC-4, DC-6, DC-7, C-46, C-54, C-97, C-118A C-130, B-377, R5D, R6D, P2V-5, F9F, F-80, F-89, F-101A, B-36G, YB-60.

**every airplane that needs a runway needs *hytrol***

*a product of*

HYDRO-AIRE *Inc.* *who also make*
FUEL PUMPS • TURBO MACHINERY
FUEL VALVES • HOT AIR VALVES

BURBANK, CALIFORNIA • *Aviation Subsidiary of* CRANE CO.

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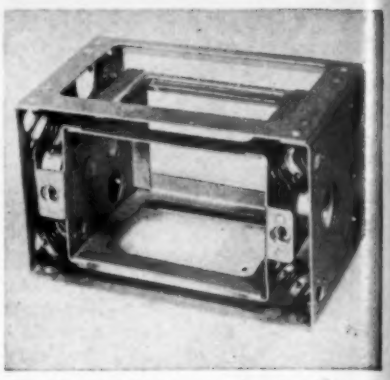


thought in design results in integral assemblies whose form and stiffnesses are engineered to the vibration, shock and installation requirements.

The assembly shown on the attached photo is typical. This is an all-metal engineered system for the protection of an airborne antenna coupler. It is capable of installation on any surface and of uniform performance regardless of vehicle attitude or environment.

Where this design philosophy has been applied, otherwise impracticable levels of equipment and vehicle reliability have been successfully achieved. Continued effort will bring still further improvement, particularly as concerns performance under combined acceleration, shock and vibratory loads.

**J. H. LASLEY**
**Director-Development**
**Servo Corp. of America**

From an overall viewpoint, one of the basic problems faced by the aviation industry is that of ever-increasing complexity of operation. Whether imposed by military requirements or commercial needs, this difficulty is compounded by the decreasing time periods permitted personnel to perform their multitudinous tasks.

There are a number of operations that demand solution and action at so rapid a pace that they are beyond human capacity. And we have reason to believe that this number will increase.

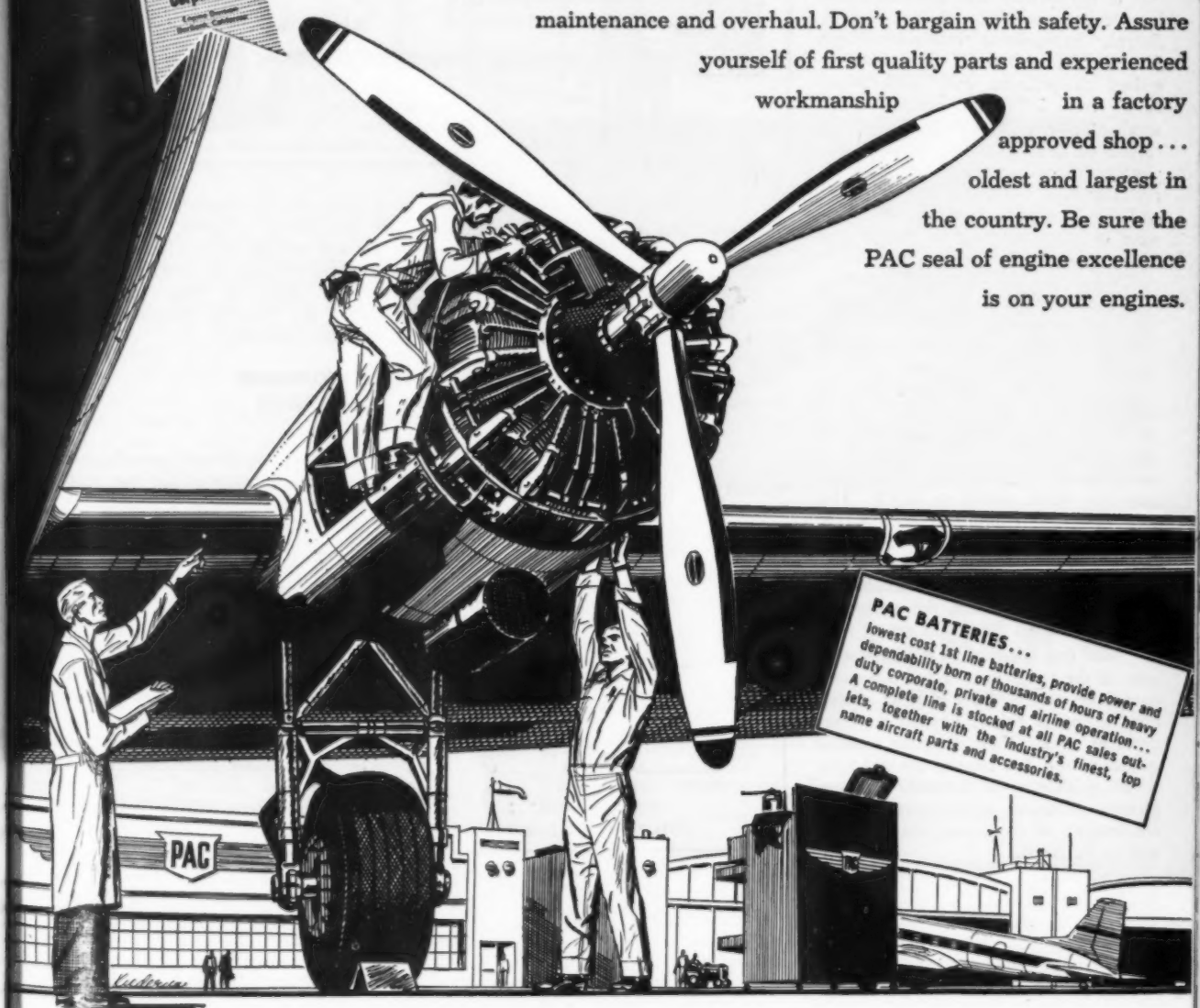
The answer is old and obvious—systems designed to sense the problem, solve them and act before the operator is even aware that the problems exist. The ultimate is a system of systems that will relieve the operator of his administrative nightmare of panels, indicators, knobs, buttons and permit him to do his proper job of management.

The evolution of electronic control is making that concept a reality in some spheres of activity. Perhaps the next ten years will see the full accomplishment of that goal.

We have taken a step in that direc-

# WARRANTY
## *of engine excellence...*

**THIS SEAL ON YOUR ENGINE MEANS DOLLARS IN YOUR POCKET** —PAC reliability has improved average operating time for all aircraft operators... business, private, or airline... who have relied consistently upon PAC engine maintenance and overhaul. Don't bargain with safety. Assure yourself of first quality parts and experienced workmanship in a factory approved shop... oldest and largest in the country. Be sure the PAC seal of engine excellence is on your engines.

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Major Overhaul and Modifications...custom interiors • instrument panels • radio installation • hydraulic and electrical systems • tank seal • painting, storage and gas service • One of the nation's most completely equipped facilities for maintenance, overhaul and modification of aircraft.

**AERO PNEUMATICS**

Manufacturers of Cabin Pressurization and Low Pressure Pneumatic Equipment...cabin pressure regulators • safety valves • shut-off and modulating valves • flow controllers • pneumatic power pressure regulators • Aero Pneumatics Div., Burbank, Calif. or Russell Associates, Brightwaters, L.I., N.Y.

**TEST & GROUND HANDLING EQUIPMENT**

Manufacturers of a Complete Line of Test and Ground Handling Equipment...portable hydraulic test stands • hydraulic test benches • magneto and propeller test stands • "tilt-arc" engine handling units • Fully staffed and equipped to design and manufacture specialized high capacity equipment to customer requirements.

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**NEW JERSEY** Linden

# PACIFIC AIRMOTIVE CORPORATION

**2940 No. Hollywood Way, Burbank, Calif.**

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tion with our 4600 automatic dead-reckoning tracer plotting board and computer. The plotting board accepts N-S, E-W, speed information and automatically plots it on a mercator chart. The plotting board has nine speeds adaptable to nine map scales, allowing its use in a variety of long and short range operations. One of the great problems facing our engineers was to cope with the distortion inherent to mercator charts which increases as one approaches the poles.

In overcoming this problem, countless performance tests were undergone. Sample navigational information was fed into the equipment and it was required to perform with uniform accuracy from 70° north latitude to 70° south latitude, about 98% of the earth's surface. Twenty-four individual plotter and counter accuracy tests were performed to tolerances of ± ⅛ in. and ± 2 minutes respectively. These were met and bettered at the 70° extremes, despite the severe distortion.

When the accuracy of the plotting board and computer were determined, the equipment was taken to the U.S. Testing Labs for rigid environmental tests in the Arctic and Tropic rooms.

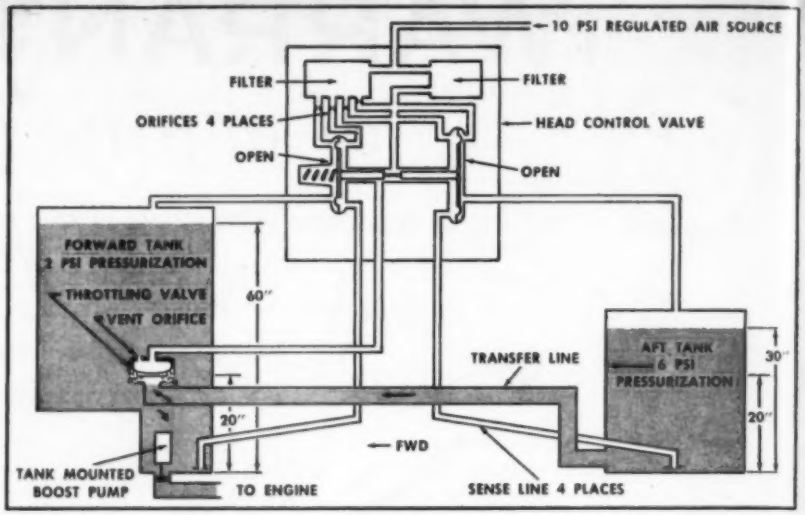
Here it was stored overnight at —85°F, and when "warmed up" to —4°F the next morning, it performed without loss of accuracy. Similarly, it was heated to 158°F and operated smoothly when cooled to 113°F. This completed, the equipment was put on a vibration table and thoroughly shaken for four hours at 5-50 cycles per second from .003-.005 amplitude. Unchanged by this severe treatment, the equipment again functioned flawlessly.

We feel that this equipment is part of the progress to a full automatic navigation system. This systems concept can be, or is being, applied to other problem areas. Fire detection, missile guidance and fire control are examples which quickly come to mind. The completion of these applications is most challenging of the immediate problems still to be faced.

**R. H. DAVIES**
**V. P.-Engineering**
**Parker Appliance Co.**

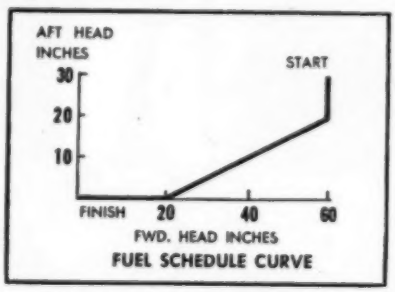
Parker Aircraft Co. (a division of Parker Appliance Co.) has developed a hydro-mechanical aircraft cg control system which we feel has been the most significant contribution by any accessories company to the aircraft fuel system state-of-the-art know-how.

In this system, the actual head in *each* tank is compared with the fuel heads in the other tanks of the aircraft, and the resulting head pressure signals control flow from the individual fuel tanks (see diagram).




A fuel tank at any location from the aircraft cg, and of any capacity, is automatically controlled as to fuel consumption so that its static head always is at a predetermined relation to the static heads in the other tanks in the fuel system. Thus, weight reduction through fuel usage is proportional to static head at all times, and resulting change in aircraft cg location can be scheduled.

In addition to control during cruising flight, the Parker system can also be applied to automatic cg control and maintenance during in-flight refueling, or to shift fuel and cg for any reason—and still retain the automatic cruising flight features.



FUEL SCHEDULE CURVE

We should like to add that this system is presently being used in the F11F-1 airplane (Grumman), with a high degree of success. We feel that this system is a definite advancement over other cg control systems, inasmuch as no electronic or electrical devices are used in any way. This system is completely pneumatic and depends only on the hydrostatic head of fuel in the tanks to be controlled.

• Most challenging of immediate problems: Fuel system components for higher temperature systems in the order of 350-400°F.

• While we are working on many programs to advance the state of the art in hydraulic and other fluid systems, and this is considered as a constant continuing program, we cannot foresee any specific technological contribution which would be considered *revolutionary*. This is with particular regard to the type of equipment that we are manufacturing.

**F. A. NEUBAUER**
**V. P.-Engineering**
**Teleflex Inc.**

Our most significant contribution to the aircraft industry in the past year has been the development and improvement of control components capable of operating accurately under the increased temperature requirements of both jet engines and aircraft.

We have increased our operation to temperatures in excess of 600°F. Accuracies in the order of .015 in. have been maintained for control systems as long as 10 feet with travels as high as 7 in. with a high degree of reliability. This is a definite improvement over previous performance since the previous temperature limit was 300°F.

At the sub-zero end of the scale, where —67°F was the previous limit, progress has taken place with the development of components which will operate accurately to —100°F when employed with the proper lubricants.

• The most challenging problems are the ever-increasing demands of higher temperatures, higher accuracy and higher efficiency in control systems. This problem is in many instances further complicated by the apparent requirements of less weight and less envelope to meet the challenge of ever-decreasing space allowances.

• The contribution our field can make to aviation is the application of a control system which provides accuracy and reliability through a large temperature span with negligible effect from engine expansion due to thermal

changes. It can also be used to provide controls in areas where the space limitations become increasingly tight and where a reduction in weight is wanted.

**J. S. PEDLER**
Manager-Aeronautical Sales
B. F. Goodrich Co.

Advancements in tire design can be listed among several significant contributions which our company have made to the aircraft industry during the past year.

Our intensive development work on aircraft tires resulted in the first high-pressure tubeless design to withstand successfully repeated dynamometer landings at 300 miles per hour—greatly exceeding military qualification requirements.

Our company also had the honor of completely equipping the first regularly scheduled airliner with tubeless tires. This marked the start of a trend which is growing rapidly because of weight saving, lower maintenance costs and added safety.

Other developments during the year included pneumatic de-icers with chordwise inflation tubes for improved air flow and a special high-shear Rivnut with a seal-type head, for blind fastening in integral wing-tank construction and various primary structure applications.

Research and development facilities in our company are geared to anticipated demands of ever higher ground speeds, air speeds and altitudes. In the decade ahead we are confident that results of our present work will be very much in evidence through new developments and even more efficient existing products.

**WALTER S. FINKEN**
Chief Engineer
General Textile Mills, Inc.

In the development of parachutes for airborne stability, we have developed three types of structure, each service-tested successfully. The advantages of these designs preclude oscillation and gyration and give selective degree in applied shock. The most challenging immediate problem still to be faced in this area is development of emergency landing facilities.

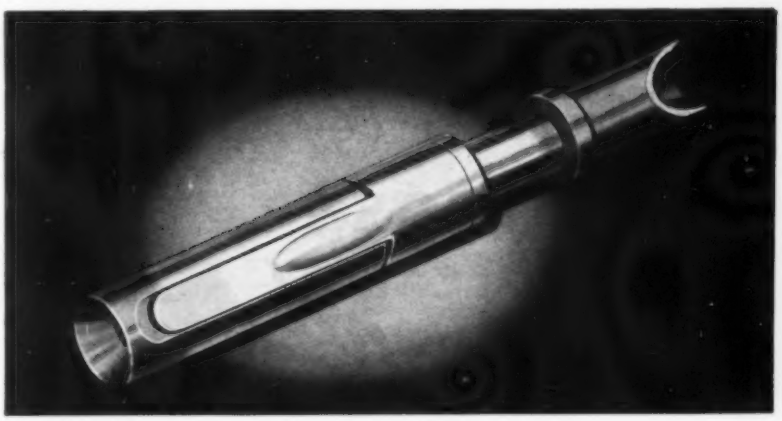
Before the turn of this decade, meteorological recordings will be acquired at fixed meridians over the earth's surface, thus giving true readings at stipulated stratifications in altitude simultaneously. Such an instrument will be electrically operated, of comparatively small structure, and low in initial cost and power consumption.

Development in the aircraft industry has since its infancy been a progression of improvements, each monitored by basic aerodynamic principles and sound physic development through research. It will suffice to state that means based in classic mechanics in the realm of gravity are in the offing, whereby a "Flying Saucer" may become as commonplace as present-day aircraft.

**H. W. JAMIESON**
V. P.-Engineering
Litton Industries

Significant developments have appeared recently at Litton Industries in inertial navigations systems. We are rapidly approaching practical sizes and weights for the use of such systems in fighter aircraft through a new method of stabilizing platforms by radically new gyro and servo designs resulting in marked accuracy increase.

Commercial application of these developments is entirely possible in the future. This should have considerable impact on the extension of world air travel routes by eliminating the need of expensive radio beacon equipment installations in difficult remote areas. Through the potential elimination of beacon equipment the complications of

"CLIP-TYPE" closed entry socket contact now standard in

**BENDIX-SCINFLEX ELECTRICAL CONNECTORS**

*Cannot be overstressed—eliminates intermittent circuit problems resulting from socket contact malfunction.*

The heart of any electrical connector is the socket contact. This is why the Bendix-Scinflex* socket contacts have always been machined from bar stock. Stampings, with their required thin sections, can be easily overstressed.

Even with the machined sockets, industry has been plagued with overstressed spring leaves due principally to the misuse of test probes and lax tolerances on pin contacts. Bendix engineers have now provided the only socket contact on the market today which completely eliminates all these problems.

The "Clip-Type" socket will not accept any oversize probe or pin, nor can one be forced into it. Also, no amount of wrenching or twisting of an acceptable pin or probe can possibly distort the spring clip. This new socket is now standard in all Scinflex connectors including those using solderless, high-temperature and thermocouple contacts.

Our sales department will be glad to furnish complete information on request.

*TRADE-MARK

**SCINTILLA DIVISION of Bendix AVIATION CORPORATION**
SIDNEY, NEW YORK

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Combines For the First Time

**Pantobase**

(All Bases)

*and*

**BLC**

(Boundary Layer Control)

It is with pride that Stroukoff Aircraft is producing for the United States Air Force the most efficient advanced assault air transport in the history of military aviation.

This development combines slow landing speeds through means of the Boundary Layer Control system, and includes the Pantobase installation, both designed by Stroukoff Aircraft Corporation.

The MS-8-1 is able to land and take-off from unprepared surfaces such as rough terrain, sand, snow, ice, ordinary runways and to operate from water as well. It will do so at low speeds never before possible with aircraft of its weight; and in half the area needed by its prototypes.

STROUKOFF AVITRUC

Stroukoff Aircraft Corporation

WEST TRENTON NEW JERSEY

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commerical aviation navigation in time of war, when radio beaconry use would be restricted, are greatly simplified.

We are also developing the possibility of integrating inertial navigation equipment with subminiature digital computers to further simplify, integrate and reduce present equipment used for navigational purposes.

• Another area of recent accomplishments at Litton Industries has been that of the development of new and greatly improved digital computer and control systems which have made possible reductions in the size, weight, complexity and cost of high performance systems of this type by a factor in some cases of 20 or more. This has been achieved primarily through advances in logical design which permit greatly more effective computation per component.

The implications to the aircraft industry are in such obvious factors as 1) higher performance; 2) greatly reduced complexity, hence greater reliability and reduced maintenance and first costs; 3) substantially less weight; 4) reduced manufacturing costs through simplified design. Digital systems can now be considered practical in many areas where analog control systems have been used in the past.

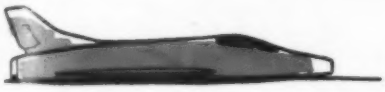
**JULIUS URADNISHECK**
**V. P.-Engineering**
**Hetherington, Inc.**

Our products are electrical switches, indicator lights, and miscellaneous other small electrical components for aircraft and missile use. As to the problems that are challenging to the switch industry, in our opinion, we can name one that is quite outstanding. This is the manufacture of a small, light, compact unit that will successfully interrupt a circuit at an altitude of 75,000 feet. A "normal" switch will sustain corona across its external connections, which eventually will cause failure. We are working on this. Its solution will be our contribution.

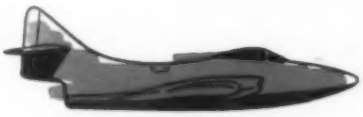
**L. T. E. THOMPSON**
**Director-Development**
**Norden-Ketay Corp.**

Recent significant contributions to the industry include development of complete semi-automatic systems for control of the delivery of weapons by aircraft, including navigational control. Another development of note is the attainment of a high degree of reliability in such systems and precision performance of the components required for the proper performance of a whole system under realistic combat environment; also, as part of this, improvement in the reliability and pre-

ACCEPTANCE MUST BE

 EARNED. THE BEST

PROOF OF THE EFFICIENCY,

 QUALITY, AND

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to the blue!
CKL conical keystone lock blind rivets
... AIRBORNE ON THE FINEST
Pioneers in the commercial development of blind rivets, Huck has continued its leadership by a constant program of research to bring you the most dependable fastener for all types of aircraft.
with brazier head.
100 degree countersunk head.
dimpled sheet, 100 degree countersunk head.
Huck CKL Blind Rivets have been proved best by the leading aircraft manufacturers. Here are the reasons:
Positive mechanical lock (not dependent on friction).
Unusually high shear strength.
Requires less clearance on blind side.
Bulbed blind side gives broader bearing area.
Positive pin-sleeve lock (no pin drop-out).
Excellent sheet pull-together.
Available in brazier or countersunk head styles.
High quality 24SRT aluminum pins used.
Absolute sealing by expansion of shank.
56S sleeve for both aluminum and magnesium assembly.
Shaving or filing will not destroy lock.
No pin trimming required.
Positive inspection from drive side.
No special drilling equipment required.
Fast delivery.
Manufactured under U.S. Patents, other Patents Pending.
HUCK Manufacturing Company
2480 BELLEVUE AVE. • DETROIT 7, MICH.
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cision of instruments for the measurement and transmission of air data.

We believe these results constitute a significant advance toward weapons systems that will operate correctly under battle conditions.

• Challenging problems for the future call for foreseeing and developing the improved or new systems for weapons delivery and transport demanded by rapidly changing operations environment. This includes recognizing the fields of technology requiring development and taking measures to advance the technical foundations accordingly.

The next 10 years may bring forth systems embodying new concepts which permit significant advance toward completely automatic controlled flight and delivery operations including necessary calculators and other components for automation.

**FRANK A. MARION**
**Director of Technical Service**
**Grand Central Rocket Co.**

Our accomplishments during the past year? The aircraft industry might be interested to know that we have developed a new, low-cost ATO (assist takeoff) unit. The non-strategic metal components of this unit are designed for mass production techniques and the propellant is made from low-cost raw materials that are abundant in this country. Incidentally, the exhaust from this ATO unit is relatively non-toxic, non-corrosive and smokeless. We believe that you will find these characteristics to be significant advancements that have been long-awaited by the industry and its using agencies.

Our most significant contribution to the missile industry is not as easy to single out. It could be any one of our high performance rockets, boosters or missile motors. It could be one of our new high energy propellants. And, it might well be the excellent reliability which we have developed in one of our very high performance units. Due to security restrictions, we cannot be more specific and we cannot discuss the details of each advancement without clearance through the usual government channels.

The most challenging problems facing this industry? Due to its great scientific and political importance, the space satellite race stimulates the imagination of all associated with this industry. Let us not forget, however, that the most challenging problem still facing this industry is not only maintaining the scientific and technical superiority required, but also establishing the stockpile of superior weapons required for the defense of the free world.

**ARNOLD E. HAYES**
**Chief Application & Service Engineer**
**Clifton Precision Products Co.**

From the weight-conscious point of view of airframe and missile producers, the outstanding synchro development of the past year is their ability, now, to call for the customary angular accuracy in production synchros weighing less than two ounces each. Synchros Size 8 (at 1.1 oz.) and Size 10 (1.8 oz.), carry substantial space and weight savings over Size 11 (3.1 oz.) and Size 15 (4.5 oz.), which has been the most popular in the postwar years.

Conversely, for given weight and space allowances, designers are packing more servo-loops into new computers to handle greater combinations of input variables, output take-offs to various pointers, sights, autopilots, plotting boards and the like.

The synchro technology that now yields miniature units in production quantities has provided extra accuracy dividends in the production of the larger units. For instrument and armament-system manufacturers working mainly to specifications that demand piece-part interchangeability under old drawings—a most effective prohibition against miniaturization—the outstanding development of the past year is the general, quantity procurability of these larger "exactly interchangeable" synchros with about half the customarily allowable errors and null voltages. Obviously, their reward is an improved system accuracy relative to the costs of assembly, calibration and inspection.

**L. L. HAAS**
**Application Engineer**
**Leland Electric Co. Div. of**
**American Machine & Foundry Co.**

The most significant contribution to the aircraft or missile industry by the Leland Electric Co. is the design and development of lightweight high speed (12,000 and 24,000 rpm) alternating current generators for use with ram air, bleed air or hot gas turbines.

These turbo-generator sets are used as prime power supplies for missiles and as emergency power supplies for piloted aircraft. As such, they must be extremely reliable even though subjected to wide extremes in temperature, humidity and altitude, as well as severe mechanical duty as the result of launching shock and airframe vibration.

The most immediate problems facing the designer of high speed rotating electrical equipment are: (1) better insulation to meet the challenge of even higher operating temperatures and (2) better bearings and lubricants for continuous high-speed, wide-temperature-range operation. As a corollary to these problems, the machine designers are analyzing heat transfer designs in an effort to dissipate greater amounts of heat in order to reduce temperature differentials.

**E. E. HEWITT**
**Chief Engineer**
**Westinghouse Air Brake Co.**
**Industrial Products Div.**

The most significant contribution we made to aviation during the past year was the successful development of some interim pneumatic valves which will withstand the extremely high temperatures encountered in high-speed flight. Earlier developments were limited to much lower temperature

*(Continued on Page 106)*

You bet your life
when you fly
"weather" without a
**LEAR ARCON.**

*NEVER fly in instrument weather without an instrument rating!*

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*serving industry through*

*coordinated precision technology*

# GPE

Kearfott gyros used for stabilization or guidance in the majority of aircraft and missiles in production today. Vertical, directional and rate-integrating gyros shown.

Link Aviation T-39D, jet flight simulator duplicating exactly cockpit of the F-89D Interceptor; Link simulators for more advanced planes may not be shown.

Automatic Airborne Navigation System; a product of the coordinated techniques and resources of General Precision Laboratory Incorporated and other GPE Companies.

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- MOTION PICTURE & AUDIO EQUIPMENT
- NUCLEAR POWER COMPONENTS & CONTROLS
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Peerless — J. E. McAULEY MFG. CO. CHICAGO

GPL — GENERAL PRECISION LABORATORY INCORPORATED—PLEASANTVILLE, N. Y.

Hertner — THE HERTNER ELECTRIC COMPANY—CLEVELAND

Kearfott — KEARFOTT COMPANY, INC. LITTLE FALLS, N. J.

One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

# AVIATION

is one of more than a dozen major industries many of whose needs are anticipated and met by the research and development activities of the producing companies of General Precision Equipment Corporation. The highly advanced aeronautical products and systems manufactured by the several GPE Companies which devote substantial resources to progress in this field are responsible for conspicuous advances in aviation and are setting new standards of performance.

The skills and resources of the producing companies of General Precision Equipment Corporation form the building blocks of GPE Coordinated Precision Technology. Through this basic GPE operating policy, each company's specialization in its areas of competence is supplemented by the resources of other GPE Companies, wherever relevant. An outstanding example of GPE Coordinated Precision Technology is the recent achievement of quantity production of the most advanced automatic airborne navigation system known. This system is the successful culmination of eight years of intensive research and development activity centered in General Precision Laboratory Incorporated and supported by the facilities and personnel of other GPE Companies.

This mutuality of ideas, techniques and tools, so effective in solving aviation problems, has likewise resulted in a diversified line of precision equipment of superior design and performance which has wide application over an extensive range of other industries.

A brochure descriptive of GPE Coordinated Precision Technology and the work of the GPE Companies is available. Address your request, or inquiries on specific problems, to:

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This new basic trainer makes it possible for the fledgling pilot to take a big step forward in the mastery of the techniques of twin jet flight.

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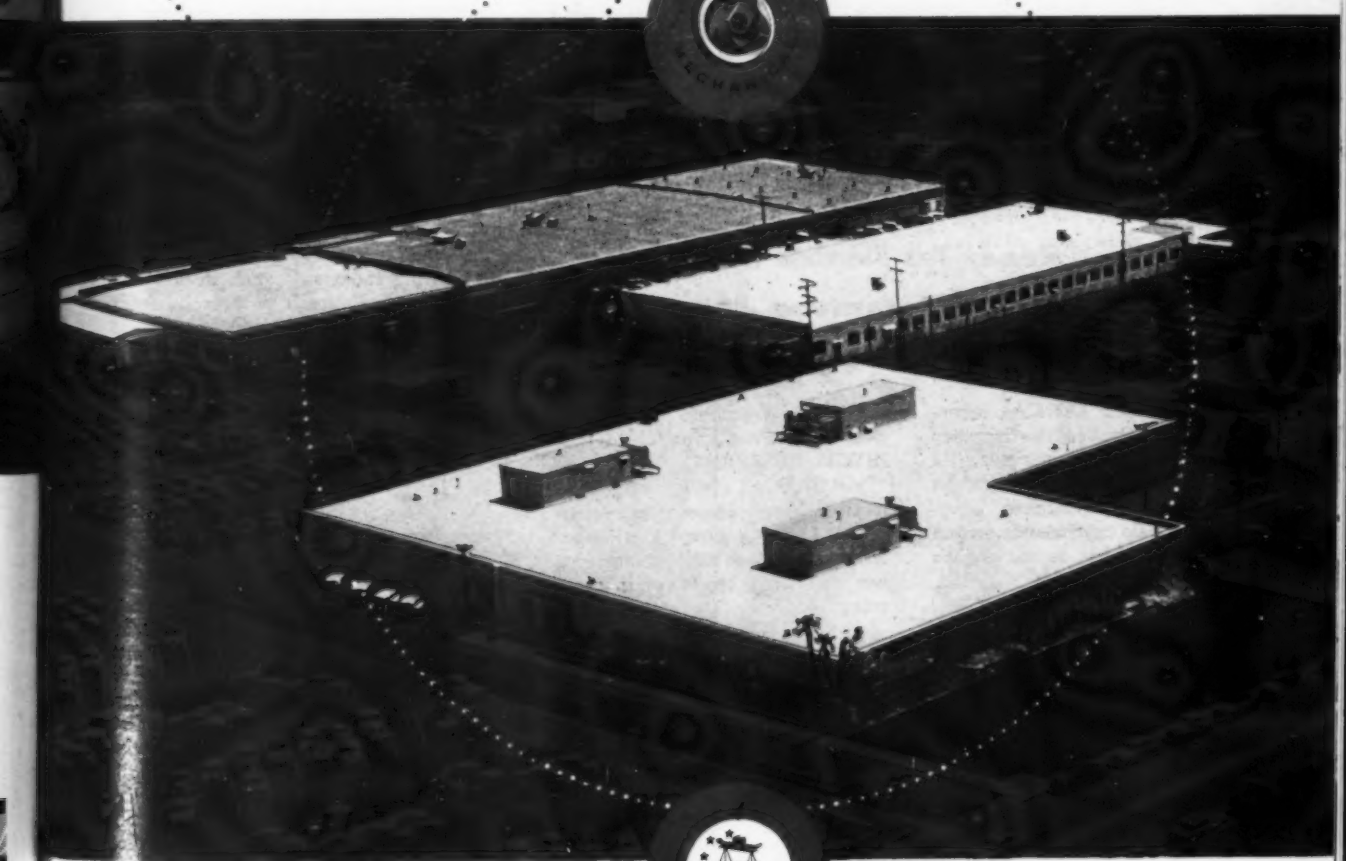

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· LIGHTWEIGHT
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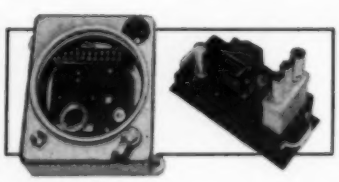
**Reads Jet Engine Speed to Guaranteed Accuracy of 10 RPM in 10,000 RPM (±0.1%)**

The new B&H TACKAL incorporates a refinement of the frequency meter principle. It operates in the low (0 to 1000 cps) range, reading the frequency of the tachometer generator on a scale calibrated in percent RPM corresponding to the engine's RPM. In addition the TAKCAL checks the tach system. The TAKCAL circuit and tachometer are parallel so that readings can be made simultaneously to determine the accuracy (or inaccuracy) of the aircraft's tach system. The TAKCAL operates during the engine run to properly set up engine controls for maximum economy and safety.

Originally developed as a component part of the J-Model JETCAL ANALYZER, the TAKCAL is now available as a separate unit for use with all earlier models of the JETCAL TESTER.

The TAKCAL operates accurately in all ambient temperatures from −40°F. to 140°F. Low in cost for an instrument of such extreme accuracy, it is adaptable to application in many other fields.



Explosion-proof TAKCAL for special applications. Measures 200 to 7500 RPM, direct reading, with ±0.1% accuracy.

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(Continued from Page 101)

ranges of perhaps 160°F to 200°F. We are now in the area of 500°F.

The general advancement of metallurgy and the production of seals and lubricants to meet high temperature requirements are the most challenging problems we face.

• We feel more system designers will be specifying compressed air as a control medium each year to avoid flammability, combustion and other high temperature problems. The pneumatics industry will contribute by providing suitable components.

### A. R. APPLEGARTH
**V. P. & Director-Engineering**
**National Aeronautical Corp.**

Our most significant contribution to the aircraft industry was an airborne DME Interrogator of higher accuracy and greater reliability than heretofore available. Direct crystal control of both transmitter and receiver components and a simple magnetostriction coding and decoding system combine to reduce maintenance problems to a minimum, a requirement of increasing importance in modern complex electronic devices.

One of the most challenging immediate problems is to simplify current radio navigation devices so as to further improve reliability, improve accuracy, and reduce the cost to the user.

The progress in simplifying and improving radio navigation devices will necessarily approach a revolutionary nature in the development of practical automatic flight.

### J. PERRY BARKER
**Sales Manager**
**Hydra-Power Corp.**

In the past 12 months Hydra-Power Corp.'s development engineering section completed design and development of an integrated tandem-powered flight control for control of aircraft surfaces such as rudder, spoiler, elevator, etc.

Common practice in the aircraft industry has been to start with separate components, then manifold the servo control valve to the actuating cylinder. Hydra-Power has packaged the valve and cylinder through a common body, with accompanying reduction in weight and space, plus greater reliability through elimination of external plumbing. This reduces possible field service problems from line fatigue failures or external leakage.

• HPC development engineering successfully designed and developed a 3,000 psi solenoid selector valve for missile application wherein the solenoids operate at extremely low electrical power of two watts and resistance of 900 ohms, thereby permitting the missile

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**You can now save from 12:01 Monday noon to 12:01 Thursday noon**

American Airlines has extended its famous Family ½ Fare Plan to Thursday mornings to give families a wider choice of fare-saving days.

Previously, it was only on Mondays, Tuesdays and Wednesdays that any person who purchased a full fare ticket could take along his or her spouse and their children for half fare. But now, American's Family ½ Fares are in effect from 12:01 Monday noon to 12:01 Thursday noon.

In 1948 American Airlines introduced the Family ½ Fare Plan. Since then, thousands of families have saved hundreds of dollars by using it. Next time you plan a family trip, remember that American Airlines offers the widest choice of days on which you can enjoy Family ½ Fare savings!

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# TANDEM RESCUE ON THE BEACHHEAD

In the tight time schedule of an assault landing, a single hitch can snowball into disaster. The job of the amphibious forces command is to see that air-ground liaison is such that hitches are anticipated. The helicopter towing operation which our artist has shown here is a case in point.

Using a tow hook, the Piasecki H-21 Work Horse has reached down to give a lift to a bogged-down weapons carrier impeding unloading operations. In consecutive field tests, Piasecki helicopters have demonstrated their pulling power in towing Navy minesweeping gear as well as military vehicles.

Here again Piasecki engineers working with the military have successfully applied the inherent versatility of the helicopter in solving crucial tactical problems.

Whether for military or commercial work, no other helicopter has the Piasecki combination of speed, range, lifting power and ease of maintenance.

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designers to greatly simplify their electrical system by elimination of relays and switches, enabling the ground signal to go directly to the valve, with accompanying reduction in weight and cost.

• The aircraft hydraulics industry faces a tremendous challenge in developing components which will be satisfactory for use in systems which see high ambient as well as high fluid temperatures. Higher aircraft speeds will impose even higher temperature limits for which our designers must find new solutions to such problems as the fluid itself, packings and metals which will withstand repeated exposure to extreme high temperatures and possibly even higher system pressures.

**P. C. SANDRETTO**
**Technical Director**
**Federal Telecommunications Laboratories, Div. of I. T. T.**

One of the most significant contributions to air operations announced this year is the development of a polar coordinate navigation system which has sufficient accuracy under field conditions to permit the generation of parallel airways with small enough spacings between them so that they may be used in place of single airways.

The use of a polar coordinate system with a computer to general parallel airways is not a new concept. Such a system has been advocated in published studies by the Air Force, the Air Transport Association, and Radio Technical Commission for Aeronautics' Committee SC-31. With parallel airways, the traffic control problem is greatly simplified, since aircraft operating at the same altitude may be assigned different airways and thereby eliminate the overtaking problem along the route.

With equipment available up to now, however, it has not been possible to generate these airways practically. The status of the situation is best summarized by quoting from Special Working Group No. 5 of the Air Coordinating Committee in its report entitled "Air Traffic Control and the National Security":

> "From a traffic control standpoint, it appears desirable to be able to establish parallel enroute courses approximately four miles apart along congested airways where possible. The present accuracy of the over-all VOR-DME-CLC system does not allow courses closer than 14 miles, however, and improvements sufficient to use four miles' separation between courses are not looked for in the Transition Period."

The 14-miles' spacing mentioned in the foregoing quotation is considered too great; yet, for 95% safety, it would

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This new Paneloc Rotary Latch is a simple and economical, strong and durable fastener for access panels, electrical control panels, inspection doors, machinery doors, and other hinged or removable covers. It permits a larger access opening, operates quickly with a quarter-turn. Entire assembly on access panel itself, eliminating many installation steps; no special tools required. Only four simple parts; made of steel, cadmium plated. Three standard sizes now available, more to be added. Special sizes and finishes available on order. Cost very low, performance unsurpassed. Write for a catalog and price list for your file.

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have to be greater. The newly announced equipment permits spacing of the order of only four miles.

The provision of a really high accuracy navigation system capable of use for generating arbitrary courses is only part of the problem. It cannot be employed to assist in relieving traffic control problems until it is equipped with automatic position reporting and telemeter links to ground flight plan storage units.

In other words, the navigation system is like a fine telephone set which has only limited use unless there is in existence automatic telephone exchanges with adequate lines between them. This problem must be worked out; otherwise, the jet age in air transport operations will suffer.

**S. C. McCOLLUM**
**Asst. Chief Engineer**
**Sangamo Generators, Inc.**

We believe the reduction of noise level to be our most significant contribution to the industry this past year. Our aim was to keep electrical noise of dynamotors to a minimum during vibration tests. We managed to reduce noise level of one design to 20% of original ripple by improved structural design and better brush and spring assemblies.

The most challenging problem facing us just now is the reduction of hash or ripple in rotating electrical equipment.

**PAUL A. PITT**
**Chief Engineer**
**Solar Aircraft Co.**

Solar's most significant contribution, which has been declassified during the past year, is, I think, the Microjet principle for control of turbojet and ramjet engines. This principle, on which we have been conducting development since 1949, is unique in its approach in that all computation is performed pneumatically by sensing engine pressure ratio parameters.

Turbojets, turboprops and ramjets are basically pneumatic devices, and their cycle performance can be most effectively described in terms of the cycle pressure ratios. With all-pneumatic controls small amounts of leakage present no problem, and certainly no fire hazard, as would be the case in the use of hydraulics. For this reason the design of seals is less critical and is not necessarily limited to the use of resilient materials, which are temperature-limited.

Storage tanks, pumps and power supplies, normally required for electrical or hydraulic systems, are eliminated. The source of fluid in the pneumatic system is assured as long as the engine

is operating. The use of pneumatics permits operation in a high temperature environment in a simple, rugged, yet tightly accurate control mechanism.

The reducing to practical producibility of materials with less acceptable strength-weight ratios for use at the temperatures to be experienced in high speed aircraft and missiles is probably the most challenging of the problems to be overcome in our field.

**ROBERT S. THOMPSON**
Sales Manager
Cornelius Co.

We believe our most significant contribution during the past year to the industry is the packaged pneumatic system which we have recently developed. Our objective in this project was to design a complete air supply system in one package by integrating the various components in order to reduce size, weight and tubing connections.

We believe the development of this package will considerably increase the use of high pressure pneumatics in aircraft. This feeling has been borne out recently by the fact that Boeing is going to use it on the B-52 and the KC-135 tanker, Canadair is going to use it on the CL-28 airplane, and a number of other manufacturers have indicated that the availability of this type package makes the use of high pressure pneumatics on new designs much more feasible.

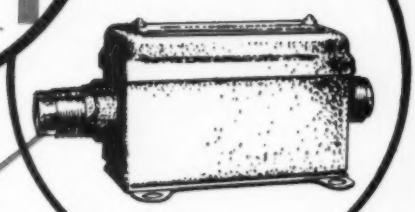
**WILLIAM P. LEAR**
Chairman of Board
Lear, Inc.

To be regarded as significant a product must not only represent an advancement in terms of competitive hardware performance, but also exploit some principle destined to spread through the art for years to come. One 1955 Lear product which we consider fits this yardstick is the all-steel gyro now in production for application to the guidance, control and navigation of tomorrow's aircraft.

This represents a successful attack on one of the major sources of error in conventional gyros: the differing thermal expansion coefficients of various critical parts. Conventional gyros contain parts made of many materials having widely differing physical properties, resulting in built-in error as operating temperatures vary. At the same time, the parts notoriously are so difficult and costly to produce by machining and grinding that gyro production has long been regarded as a prime limitation on the nation's war mobilization potential.

Lear has substituted, throughout,


GLA ignition . . .



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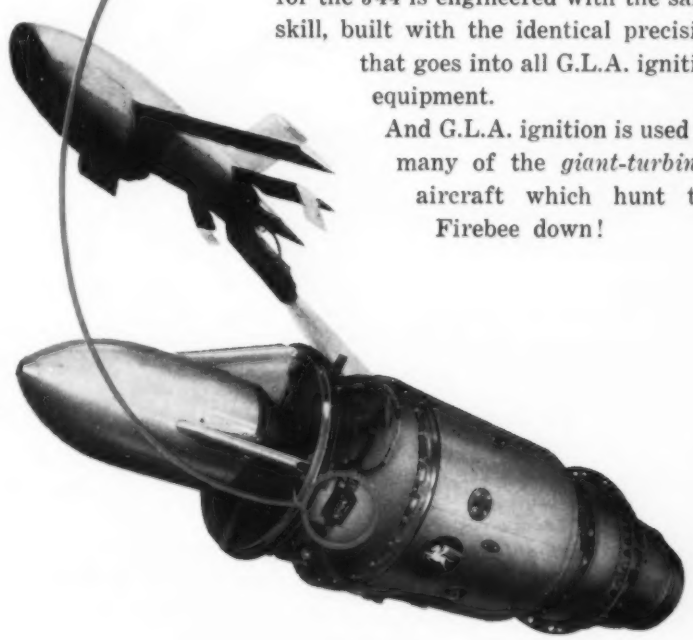
*. . . the compact engine that powers the Ryan Firebee!*

This specially designed ignition unit for the J44 is engineered with the same skill, built with the identical precision that goes into all G.L.A. ignition equipment.

And G.L.A. ignition is used on many of the *giant-turbined* aircraft which hunt the Firebee down!



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# ANNOUNCING

## a new long life BG spark plug

The new BG platinum electrode spark plug – RB 39R – has now been CAA approved for Pratt & Whitney's R4360, R2800, R2000, R1830 series engines.

Designed in the tradition of quality established by BG, a leader in the field since 1917, the RB 39R features a new anti-fouling ceramic core design, an all weather top, and a new ground electrode design for long life.

As an added service, BG maintains a facility for factory overhaul of all platinum electrode spark plugs. Factory overhaul combines economy with long life and trouble free service.

the name that is first with aircraft engineering and maintenance personnel

For information concerning the RB 39R and other BG products, write to:

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parts made of steel to get a guarantee of consistent performance over an extreme temperature range, and we are forming these parts by the most inexpensive pressing and stamping techniques, easily maintaining the required tolerance.

The result is a new line of instruments that is getting enthusiastic reception for superior accuracy, with added reliability, lower costs and expanded productive capability thrown in. We think we have put into gyro practice a significant example of horse-sense design policy.

• **Today's challenge** of practically unlimited power and prospectively unlimited range is the same for all of those branches of aviation which are concerned immediately with what lies a decade ahead.

We are facing, rather suddenly, a conceptual latitude that finds no precedents in the last fifty years of designing airplanes up to the available power and then figuratively washing our hands.

It would appear from this that the big challenge is entirely at the conceptual level—in the technical and requirements branches of the Services, and in the prime airframe preliminary design offices.

This, however, is not the whole truth, because we have come now to a point where every new performance target puts increasing reliance on correspondingly increased capabilities of critical sub-systems. With each new family of aircraft—with each brilliant burst of imaginative aircraft design or mission assignment in the Services or the prime plants—comes a need for more "automaticity" in dozens of control systems, typified by air inlet control for supersonic jets, thrust reversal actuation, boundary layer and control surface actuation, and advanced kinds of flight stabilization, armament, radar, camera and navigational controls.

**Success in the provision,** simplification and combination of such controls and their master reference devices henceforth will define overall performance with the same finality as aerodynamics, structures and propulsion have done in the past. They have become an indispensable part of the first "back of an envelope" layout.

The challenge to seasoned designers and suppliers of such secondary systems is intensified by the difficulty of anticipating sufficiently in advance what is going to drop out of the conceptual hassle as an immediate hardware requirement. This problem is in the process of being solved by its definition.

Lear's key specialists are being drawn closer and closer into the most advanced design thinking of the Serv-

*To help build a stronger national defense . . .*
*to speed a brighter industrial future . . .*

*Avco Mfg. Corp. announces the formation of*

# AVCO ADVANCED DEVELOPMENT DIVISION

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*An organization created specifically to meet the complex scientific and production problems of Defense and Industry.*

For some time now, a long-held conviction of Avco planners has been growing into reality. It is the idea that today's complex and closely interrelated scientific needs can best be met by an organization *concentrating its entire efforts* on research and development.

Now, gathered in two quiet New England towns, Stratford, Conn., and Everett, Mass., to form the "cadre" of Avco Advanced Development, some of the world's ablest scientists are setting this concept in motion.

These men are tackling missile projects so broad that they will encompass most major areas of science. In optics, metallurgy, electronics, heat transfer, aerodynamics—where so much valuable information lies hidden—they are searching the very frontiers. Their explorations are probing the tremendous natural resources of our world—nuclear, even solar—to turn their promise into products for *defense*, for *peace*.

This, then, is the mission of Avco Advanced Development, working with the military and with Crosley and Lycoming Divisions—supported by Avco's 20 installations and 22,000 men. Avco Advanced Development's scientists and engineers are doing important and exciting work. You'll be hearing from them soon.

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**Write E. W. Stupack, Personnel Manager, Room 402, Avco Advanced Development Division, Stratford, Conn., or phone Bridgeport, Conn., DRexel 8-0431**

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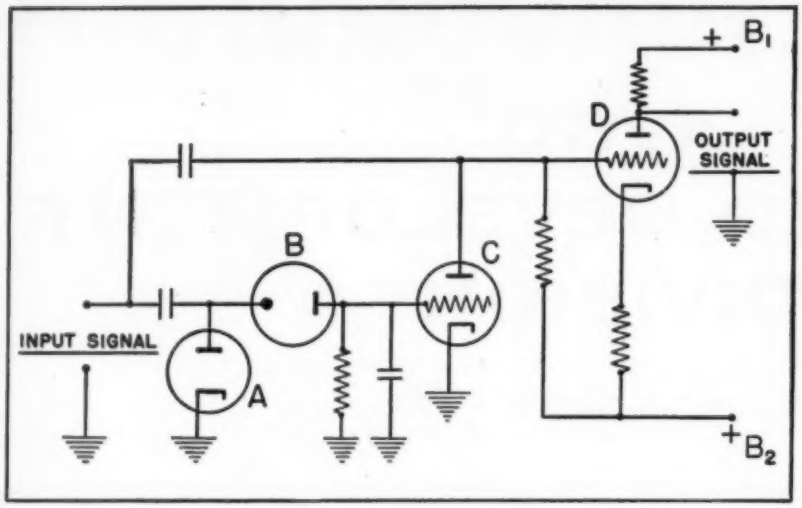


# ELECTRONIC AMPLIFYING SWITCHING CIRCUIT

Both electronic switches and electronic amplifiers are used successfully in computer design. A very unusual circuit, patented by the Ford Instrument Company, combines positive switching action with amplification, and is particularly useful in such applications as multi-speed servomechanisms, in which several signals are to be applied selectively to operate the mechanism. When such a circuit is used, the inactive signals can be left connected without producing any noise whatever in the response to the active signal.

The key to the operation of this circuit is the voltage-doubler circuit consisting of diode A and gas tube B. When the signal voltage is below a specified level, gas tube B cannot fire and triode C draws a very large current, making the grid of tube D at almost ground potential. The cathode voltage of triode D is at a voltage $B_2$ above ground, thereby effectively cutting tube D off. If the signal voltage is above the specified level, gas tube B breaks down, cutting tube C off, thereby permitting tube D to conduct and actuate the servomechanism. The amplification produced by tube D, in addition to providing the required signal level at the servomechanism, contributes also to the effectiveness of the electronic switching, and the resultant circuit is more compact and has a higher parts economy than produced by the use of a separate switch and amplifier.

Electronic circuitry is but one of the many facets of Ford Instrument design and development. Ford Instrument engineers work every day with control systems, using mechanics, electronics, hydraulics, electro-mechanics, magnetics, and atomics. If you have a problem in automatic control, Ford Instrument stands ready to help you.

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ices and the prime plants, where one of the first questions now being asked (instead of the last) is: Can it be satisfactorily automatized? On this basis a "new break-through" in technical teamwork is in the making, testing whether man, by collective genius, is really going to accomplish just about anything he can conceive.

• **The term "revolutionary"** shakes us up a bit, because we have a five-year engineering program and a ten-year planning program depending rather heavily on Newton's laws. In our industry, with its wide spread of electric-mechanical-electronic combinations, perhaps Lear's only accomplishment worthy of being called revolutionary in the next decade will be our continued leadership in the design and production of our chosen lines. All of our plans focus on a determination that Lear alone shall obsolesce Lear products.

Too often a "revolutionary" concept is merely the fruit of opportunism where, as in all gambling, early success is significant only as a promise of later failure, because it rests on chance and timing rather than long-range research and development programming.

Hardly a month passes without our people accomplishing something which a few years ago we should have regarded as impractical if not impossible, and of course we do have some "dreamy" development targets, especially in the field of business aircraft equipment and automation in general. But we don't schedule flashes of genius, and we don't seek the spectacular for the thrill. For example, we think that many a costly campaign that today is seeking to achieve the theoretical ultimates of accuracy in a gyro might better invest the same ingenuity in a search for workable, producible alternatives.

However, we do look upon our NAFLI attitude indicator as having revolutionary significance that will help make some history in the next few years. It represents the first production departure from the traditional method of showing a moving horizon instead of a moving airplane when presenting roll and pitch data to a pilot, combined with a showing of aircraft heading that has unique operating advantages. It prepares the way for advanced, simplified cockpits in which pilots will have only to react to, rather than interpret, the panel data.

**JOHN K. MORRIS**
**Manager-Engineering**
**Western Gear**

Most significant contribution to the aircraft and missile industry during the past year has been the general moving forward of gearing and electrical equipment. Specifically increased rotational

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Flexible P3-B Back-Pack Parachute—thousands in use by the U.S. Air Forces and other governments, test pilots, leading aircraft manufacturers.

All Pioneer Parachutes are equipped with the exclusive "Quick-Fit"* Harness. Provides perfect fit in less than 3 seconds; allows free movement.

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# PIONEER PARACHUTE

## *for every plane . . . for every purpose!*

Everywhere you look in the field of parachutes—Pioneer is pre-eminent in the vanguard of aviation progress. Aviation authorities have hailed the P7-B and P9-B Guide Surface Personnel Parachutes* as the most significant new design in life-saving parachutes for jet-plane speeds.

From Military Chutes for paratroop training and paratroop use to Ribbon Chutes that act as brakes for jet planes; and from the smallest chute for recovery of instruments from guided missiles to the largest 250-foot Cargo Chutes that deliver heavy cargoes to any spot in the world, however inaccessible, Pioneer's unparalleled know-how in design and manufacture has produced parachutes with a world-wide record for positive performance.

* Patented in the U.S., Great Britain, Canada and other principal countries of the world. Other patents pending.

**PIONEER PARACHUTE COMPANY, INC.**

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and pitch line velocities were successfully achieved.

Considerable advancement and research determining suitability of new materials such as titanium, etc., for gearing has been accomplished. Sizeable increases in maximum operating temperatures in both gearing and electrical equipment were achieved. This past year exceeded the previous year.

The immediate problem to be solved in our area of the industry is the effects of speed temperature and vibration on mechanical equipment.

**EDMUND D. HOLLAND**
Vice President & Director of Engineering
Ozone Metal Prod. Corp.

Our most significant contribution is the accuracy in manufacturing control surface tandem power control valve assemblies (plunger & sleeve) for dual systems. The unit was designed by Republic Aviation Corp., but manufacturing techniques were developed by Ozone. The unit requires the 7" long ⅛ ϕ hole to be round and straight to within .00005 then fitted for .00012 ϕ clearance with plunger.

Our most challenging problems are developing high temperature (600° F) packings and fluids which are also good for service at —65° F.

**EUGENE CONNELLY**
Chief Engineer
Electro-Snap Switch & Mfg. Co.

The aviation switch industry has been long in looking for a rotary switch seal that will hold a leak rate of less than 1 micron cubic ft./hour. We have developed a rotary seal which will do that. In fact no detectable leakage is apparent when tested on a mass spectrometer.

The reduction of size, weight and increased reliability of aircraft switches is the most challenging of the immediate problems still to be faced in our area of the aviation industry.

During the next 10 years a change to completely hermetically sealed switches will be our technological contribution of a revolutionary nature to the aviation field.

**EDWARD F. KOLAR**
General Manager
Bendix Aviation Corp.
Red Bank Division

I consider the work done by the Red Bank Division in the past year on the extension of the range of working temperatures to be highly significant. In electronics our hard glass tube, the 6094, works in temperatures up to 350° C. In aircraft generating systems where


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IMPROVES DRY LAY-UP
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Heat distortion as high as 187° C., or 369° F., according to A. S. T. M. D-648-48T, run at 264 psi.

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Laminates made with this process are classified "fire retardant" under Underwriters' Flame Test on sheeting material... as "self extinguishing" according to L-P-406 b, Method 2021.1.

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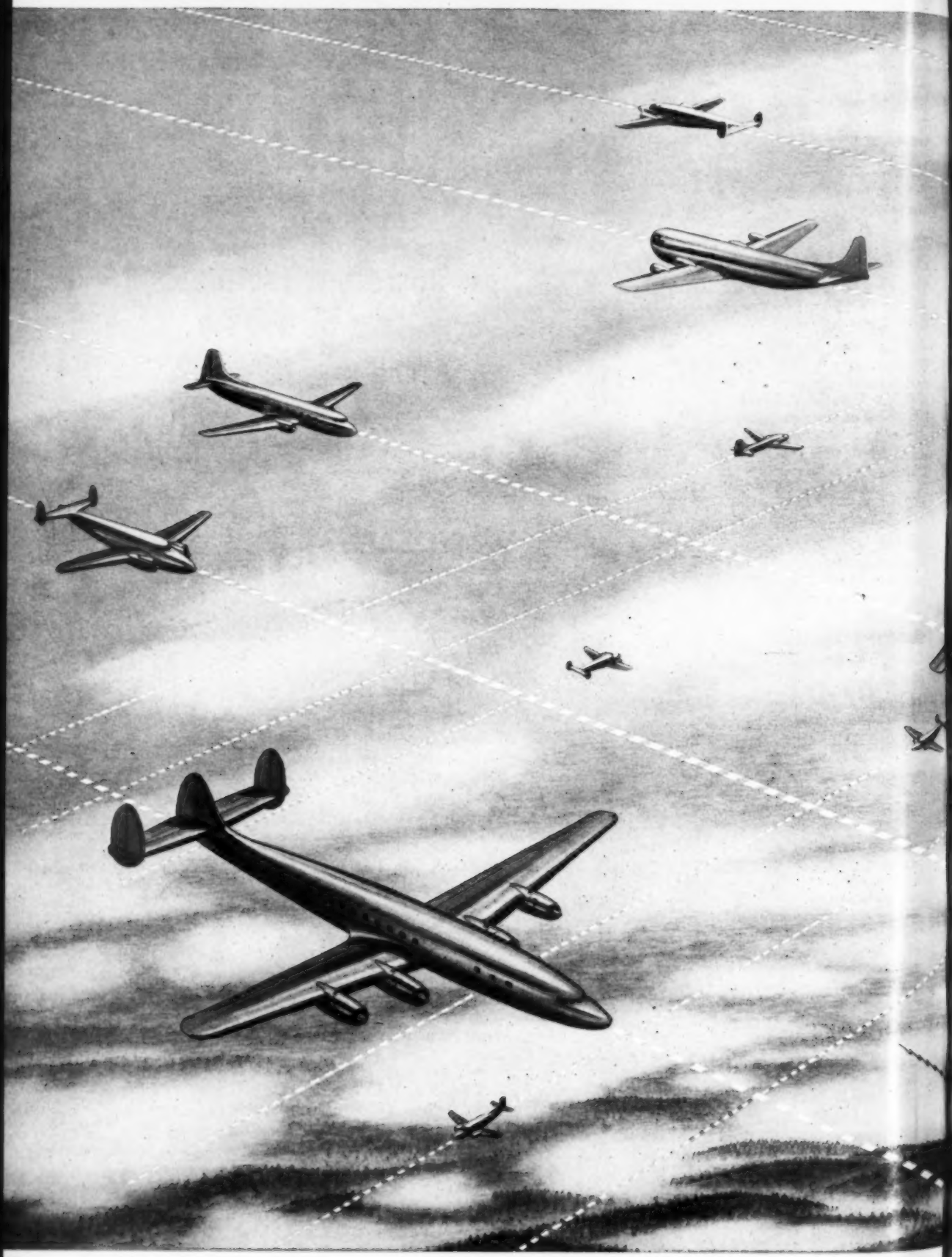

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## revolutionary IT&T development

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This remarkable system can virtually make the sky as much as "ten times wider."

Now *parallel* all-weather airlanes can be marked off in the sky by electronic means...airlanes that lie side by side, only a few miles apart, yet never meet. This can now be accomplished through a computer which derives its information from a single airborne "package" that measures the distance to a known ground station and determines bearing with pinpoint accuracy.

Thus, in heavily-traveled areas, multiple and accurate routes can be provided for aircraft to fly safely and efficiently, maintaining heavy traffic schedules in adverse weather.

TACAN is the result of a series of development programs sponsored by the U. S. Navy and the U. S. Air Force at Federal Telecommunication Laboratories, a division of IT&T. Federal Telephone and Radio Company, division of IT&T which now manufactures the military version of TACAN, will also manufacture and market the commercial aircraft and private flier versions of the equipment.

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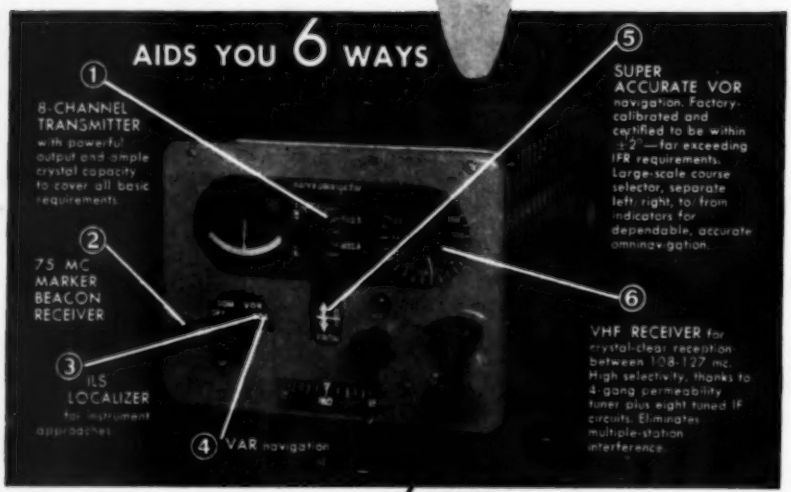
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previously air for cooling had to be held to 40° C our new high temperature generators use 120° C air.

The most challenging of the immediate problems still to be faced are the further increase in the reliability of electronic tubes despite higher temperatures and increased shock and vibration, the further improvement in cooling aircraft generating equipment and the perfection of transistors for consistent mass production.

The most revolutionary will be electronic controls of all description permanently built into the airplane, using transistors. This will enable the airplane to take off, cruise, observe all conditions constantly and land without pilot.

**WALTER W. PATRYLO**
**Director of Engineering**
**Hindle Transformer Co., Inc.**

I consider the increased reliability in metering and communication equipment the most significant contribution to aircraft during the past year. This development consists of higher heat dissipation of components, weight reduction and resistance to shock and vibration. This means greater efficiency and longer life of electronic equipment.

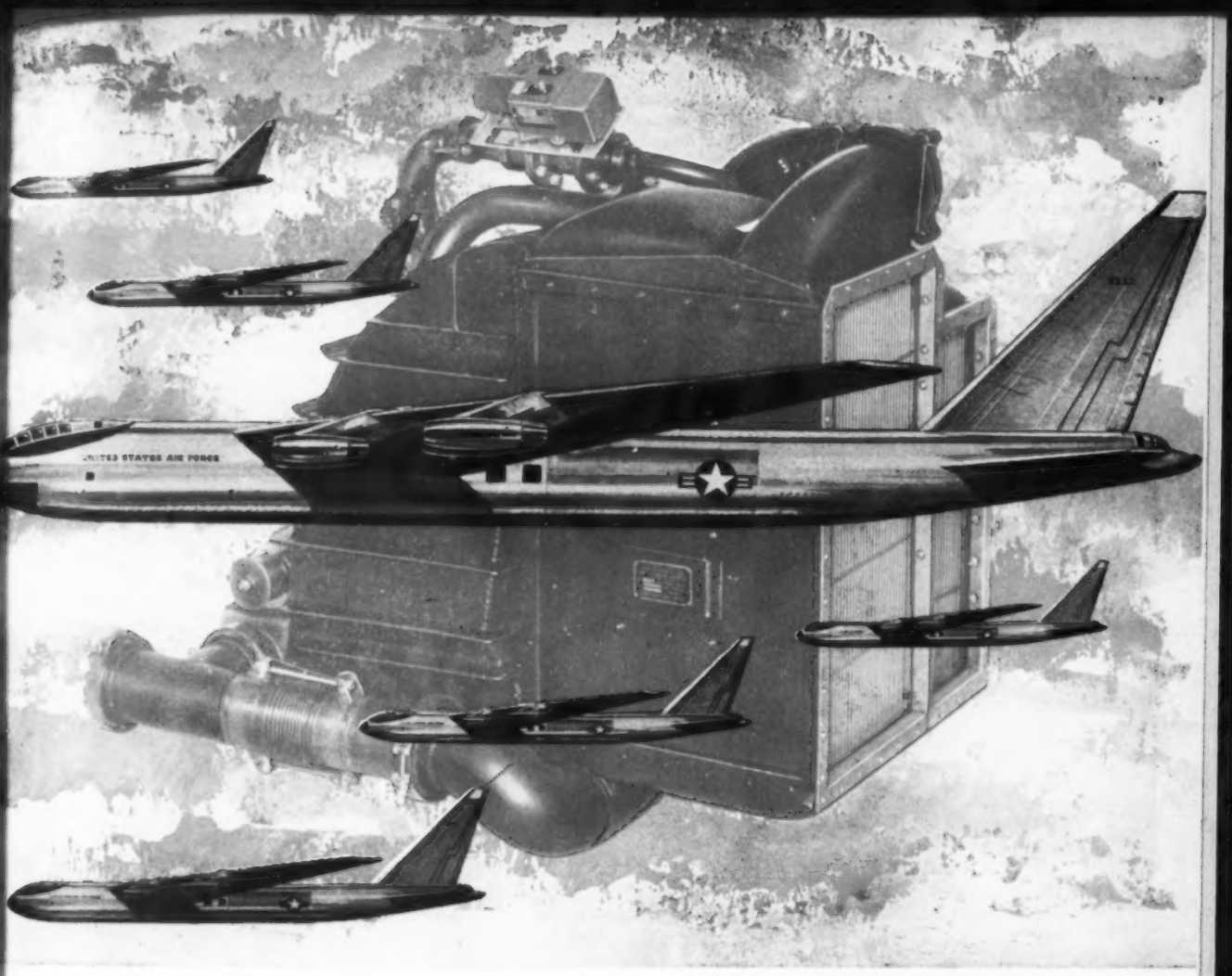
In my opinion the most challenging problem is production of more sturdy components using transistor oscillators, magnetic amplifiers and miniature transformers.

In the near future, we will probably use solar batteries for prime power in metering and communication equipment. This, combined with nuclear propulsion, will revolutionize control equipment in aviation.

**JOHN J. KARDYS**
**Chief Engineer**
**Accessory Controls & Equipment Corp.**

Our problem in the pneumatics field was to design and develop a means for continuously dehumidifying high pressure air by means of a small, compact device that could be used alone or built into available compressor units both stationary and mobile. Further, we had to insure removal of all foreign material. Desiccant systems used for this purpose are cumbersome and, unless frequently reactivated, tend to be very inefficient not only in permitting moisture to pass through the system, but also occasionally passing damaging particles of the desiccant itself.

Our solution to the problem is in the form of the ACE-17 Dehumidifier which operates on the refrigeration principle combined with the dehumidifying action of the compression cycle already available. Up to the present we have made several installations which



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## THE EIGHT-JET BOEING B-52

The Boeing B-52 jet bomber entering operational service with the Strategic Air Command this spring becomes the world's first heavy jet bomber to go into service.

Joining its medium jet bomber teammate in SAC—the Boeing B-47—the B-52 "Stratofortress" greatly strengthens America's Air Arm. A high flying, high speed heavyweight with a range longer than that of any other operational jet aircraft, it is destined to be the backbone of SAC's striking force for some time to come.

To cool the crew and the tons of intricate equipment aboard the B-52, Boeing picked a highly efficient cooling system designed and produced by Stratos.

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successfully dry 3,500 psi air to a dewpoint of —65° F on a continuous duty cycle. Ratings of 5,000 psi and 16 cfm are fact, and capacities up to 50 cfm are under development.

We feel that we have found a satisfactory solution to the present problem and are prepared to tackle higher pressures and flows. Although this particular problem arose from the aircraft industry, we feel the answer very probably has many other applications.

One of the most aggravating problems that we must face is that of the degree of accuracy demanded by customers in instrumentation and controls. Reference is made particularly to such things as temperature and pressure control systems, speed regulation, and others of similar nature. The manufacturers of the components involved are faced with the solution to such problems, but if the answer is not available from the manufacturer, it falls upon the equipment builder to attempt to improvise.

Results of this type of operation are questionable. It would appear that some sort of survey should be made periodically to determine the thinking of engineers in terms of what accuracy may be required for this, and to provide a target at which to shoot in the future. It is realized that everyone is striving for improvement of his product at all times, but it is possible that something concrete might be of assistance.

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High performance plus work horse dependability makes the De Havilland Otter the pride of Canada. It operates off pocket sized fields... carries a 1½ ton payload... has the ruggedness demanded by the bush country... and it is doing this with *Lund-supplied* P & W R-1340-AN2 engines. These are low total time engines that have been rebuilt to factory-new specifications by Airwork Corporation—and tailored to the Otter configuration by Lund.
Lund has the facilities and the inventory to provide modernized P & W R-1340's, R-1830's, R-2000's and R-985's *in any quantity* tailored to specific airframe configurations. Every engine carries the symbol and warranty of an outstanding overhaul base—a firm guarantee that all the latest P & W and CAA modifications have been incorporated. Whether you are a corporate owner, an aircraft manufacturer, or an airline executive—it will pay you to *call Lund first.*
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### NORMAN F. HOSFORD
**Chief Engineer**
**Bendix Aviation Corp.**
**Pioneer Central Div.**

We regard the supply of liquid oxygen systems in production quantities to the Air Force for the first time in history as our most significant contribution to aviation during the past year. This liquid oxygen equipment will eventually replace all gaseous oxygen systems for breathing purposes in high altitude aircraft. Use of liquid oxygen results in exceptionally high savings in weight and space over previous systems.

We find that the most challenging immediate problem still to be faced is the development of a completely satisfactory pressure suit for high altitude flying.

### TOM W. LE NAY
**Director-Development**
**Perkin Engineering Corp.**

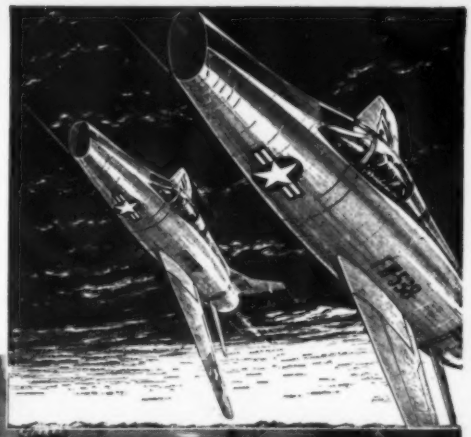
Our company has developed a line of high voltage airborne radar power supplies with a high degree of reliability. These units withstand high temperature (125° C) and high altitude (70,000 ft. and up). The units are potted with special epoxy resins developed for this particular application. They have voltage outputs of 6000 to 10,000 volts. As far as we know, we are the first company to manufacture successfully a potted unit at these temperatures and voltages without the use of oil as a filler.

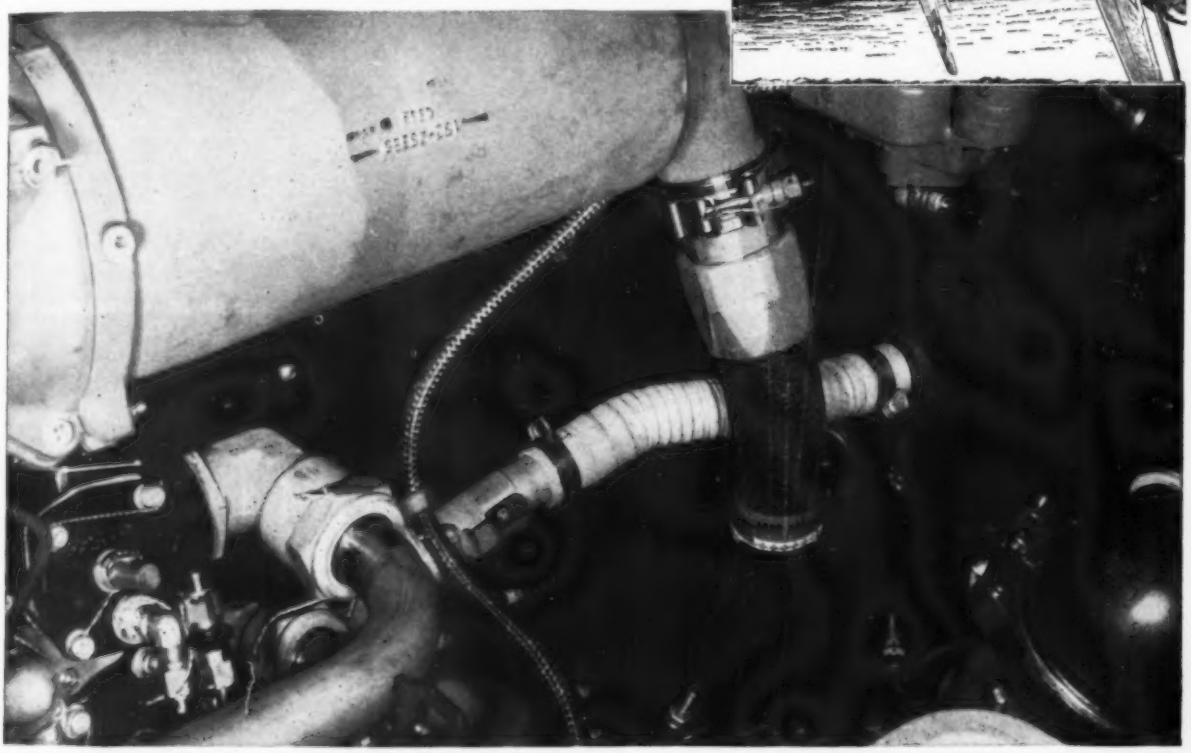
### JOHN P. SHANLEY
**Chief Engineer**
**Control Products, Inc.**

Perhaps our company's most significant contributions to the industry during this past year are: (1) the increasing of the working temperature of super high temperature thermal switches from its previous maximum of 1,750° F to 2,200° F, with capability to withstand overshoots for 10 seconds to 2,200° F without failure; and (2) the development of a very thin flat hermetically sealed thermal switch for sensing the surface temperature of high-speed aircraft, also suitable for imbedment in ultra-thin heaters (max. working temperature 650° F, previous working temp. 350° F).

In our opinion the most challenging

# Fast Filter Changes on the F-100 with Marman V-Band Coupling and Aeroquip Hose Lines





Here is an excellent example of how Marman clamps and Aeroquip hose lines work hand in hand to simplify aircraft plumbing installations:

On the North American F-100, a compact Marman stainless steel V-band coupling joins the fuel supply line to the filter. Utmost simplicity is achieved because *the clamp flange has been machined right on the Aeroquip special hose fitting!* The Marman "quick-coupler" latch adds quick assembly and disassembly advantages, and locks securely.

Marman clamps, straps, and couplings are used throughout the F-100 and many other planes for a wide variety of applications. Engineering assistance is available. Write for information.

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ROHR has won fame for becoming the world's largest producer of ready-to-install power packages for airplanes like the all-jet Boeing B-52, the Douglas DC-7 and other great military and commercial planes.

But the whole ROHR story is in millions of parts, for in addition to power packages ROHR builds over 30,000 other different parts for aircraft of all kinds.

**When you want aircraft parts better, faster, cheaper . . . call on ROHR and the ROHR engineering skill and production know-how gained from building thousands of power packages—and millions of other aircraft parts.**

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AIRCRAFT CORPORATION

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problem in this field is the development of reliable thermal switches capable of operating in the 2,000° F range and beyond. These switches should be hermetically sealed. A truly hermetically sealed snap action switch with higher current ratings would be of great value.

It is possible that in the next 10 years an area type temperature detecting device which would sense 100% of a given surface may be developed. It would be environmental proof and would eliminate hot spots which are missed with spot type thermostats.

**GEORGE A. STARBIRD**
**President**
**Meletron Corp.**

During the past year, our most significant contribution to the aircraft and missile industry has been the development of new prototype pressure switches which have achieved a material reduction in size and weight without sacrificing ruggedness, dependability and performance.

In doing so, we have retained a simplicity in design and construction that will lend itself well to the solution of certain basic problems—namely, operation at extreme temperature, —60° to +500° F, vibration stability, etc. We have eliminated the use of seals and springs, which prove troublesome in most miniaturized units, and have achieved a similarity in materials, using only proven and stable materials, principally stainless steel and aluminum. Reduction of weight has been as much as 50%, proving units as light as 4½ oz.

In the temperature field we have developed a switching element that is stable to 500° F. It is humidity-resistant as well. We feel that we have achieved a major break-through in pressure switch design which will benefit aircraft, aircraft engine and missile manufacturers.

Our most challenging immediate problem is the further refinement of production techniques to keep pace with our developmental work.

It is difficult to look ahead 10 years in our field, since much depends upon the development which will come in new materials which may be adapted to our use. We believe our major barrier to be electrical and thermal in nature.

**ROBERT M. STANLEY**
**President**
**Stanley Aviation Corp.**

In the field of emergency escape, the most challenging problems are those of system reliability and the orientation and stabilization of the escape unit, whether it be a seat or a capsule, so that the human body can withstand the high decelerative forces caused by the airstream.

Recently much has been published about the courageous efforts of Lt. Col. Stapp of the Aero Medical Division of the Air Force wherein he has been subjecting himself and other volunteers to an extensive series of tests on high speed rocket sleds at the Holloman AFB. Specifically, the work done by Col. Stapp and his associates has shown the capabilities of the human body with respect to what the physiological limits are.

It now remains for the escape device engineer to utilize these findings and incorporate in the design of emergency escape equipment factors which will bring about the development of escape equipment which will work successfully under the most adverse conditions.

It is our belief that during the coming year great advances will be made in the emergency escape equipment field and many of the problem areas will be reduced with the end result of more lives being saved by improved equipment.

• **In the field of training aids,** high cost, early obsolescence and long delivery of current projects make it imperative that new ideas and techniques be employed in the design and production of training devices. To attack this program, Stanley first assembled a training devices team consisting of design engineers, psychologists, and a training specialist. This group works on the philosophy that "a definite need exists for a new source of low cost training aids of simplified design, having a high training value and a short delivery schedule."

In applying this philosophy, Stanley


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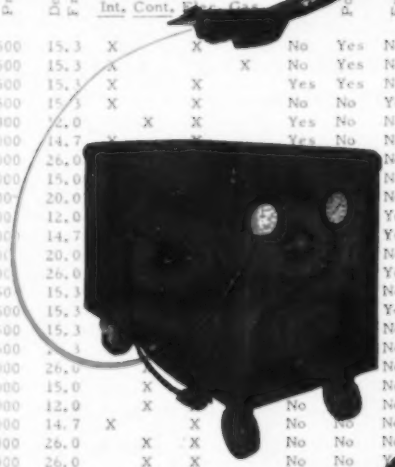
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KC-231 | 3500 | 15.3 | X | | X | | No | Yes | No | 750 | 52 | 37 | 66 |
| KC-262 | 3500 | 15.3 | X | | | X | No | Yes | No | 900 | 72 | 44 | 92 |
| KC-278 | 3500 | 15.3 | X | | X | | Yes | Yes | No | 1100 | 52 | 37 | 84 |
| KC-279 | 3500 | 15.3 | X | | X | | No | No | Yes | 600 | 40 | 37 | 66 |
| KC-292 | 6000 | 12.0 | | X | X | | Yes | No | No | 1800 | 55 | 40 | 90 |
| KC-306 | 5000 | 14.7 | X | | X | | Yes | No | No | 1700 | 53 | 38 | 88 |
| KC-321 | 2000 | 26.0 | | X | X | | No | No | No | 1000 | 72 | 44 | 92 |
| KC-347 | 1000 | 15.0 | | X | | | No | No | No | 800 | 50 | 35 | 82 |
| KC-353 | 500 | 20.0 | | X | | | No | No | No | 500 | 48 | 36 | 52 |
| KC-354 | 600 | 12.0 | | X | | | No | No | Yes | 1450 | 55 | 40 | 72 |
| KC-355 | 500 | 14.7 | | X | | | No | No | Yes | 1350 | 53 | 38 | 70 |
| KC-356 | 500 | 20.0 | | X | | | No | No | No | 850 | 48 | 36 | 70 |
| KC-357 | 200 | 26.0 | | X | | | No | No | Yes | 650 | 72 | 44 | 74 |
| KC-358 | 350 | 15.3 | | X | | | No | No | No | 600 | 40 | 31 | 60 |
| KC-359 | 3500 | 15.3 | X | | X | | Yes | No | Yes | 800 | 52 | 43 | 66 |
| KC-360 | 3500 | 15.3 | X | | X | | No | No | No | 880 | 40 | 31 | 72 |
| KC-361 | 3500 | 15.3 | X | | X | | No | No | No | 1250 | 72 | 44 | 110 |
| KC-362 | 2000 | 26.0 | | X | X | | No | No | No | 600 | 72 | 38 | 74 |
| KC-363 | 1000 | 15.0 | | X | | | No | No | No | 640 | 38 | 29 | 76 |
| KC-364 | 6000 | 12.0 | | X | | | No | No | No | 1450 | 55 | 40 | 84 |
| KC-365 | 5000 | 14.7 | X | | X | | No | No | No | 1300 | 53 | 32 | 70 |
| KC-366 | 2000 | 26.0 | | X | X | | No | No | No | | | | 68 |
| KC-367 | 2000 | 26.0 | | X | X | | No | No | Yes | | | | 68 |
| KC-368 | 2000 | 26.0 | | X | X | | No | Yes | No | | | | 4 |
| KC-369 | 2000 | 26.0 | | X | X | | Yes | No | No | | | | |
| KC-370 | 2000 | 26.0 | | X | X | | Yes | Yes | No | | | | |
| KC-371 | 1000 | 15.0 | | X | X | | No | Yes | No | | | | |



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has completed or is in the process of building a jet cockpit trainer, helicopter instrument trainers, a set of general trainers for the latest weapons, airship trainers and an omni-range navigational trainer. Field acceptance of these training devices has verified the soundness of the Stanley philosophy. A study for a helicopter operational flight simulator was completed for the Navy.

**JULES P. KOVACS**
**Vice President**
**Purolator Products, Inc.**

Our most significant contribution to the industry is the project which we are currently working on, and which also presents one of the most challenging problems to be met—the development of high temperature filters, 65° F to 600° F for removal of moisture and/or oil mist from air-filtration equipment for acids, alkalies, etc., in all types of fuel and lubricant systems.

**CLYDE A. PARTON**
**Director-Engineering**
**Minneapolis-Honeywell Regulator Co.**
**Aeronautical Div.**

Most of our bigger projects are classified. However, we believe one important contribution is the transistorized fuel gauge amplifier. The multiplex fuel gauge amplifier is another. This results in additional saving in weight, number of components, and cost of fuel gauge systems through the use of phase sensitive circuitry that permits the use of a single amplifier per pair of fuel tank systems within which fuel quantities are to be measured.

It also permits simultaneous readings, or fuel readings in one case and center of gravity control in the other—as examples of flexibility.

The most challenging problem now to be faced is high temperature.

The next 10 years will probably bring forth new materials that will withstand greater temperatures as well as shock and vibration.

**DR. ARRA S. AVAKIAN**
**Executive Engineer**
**Vectron, Inc.**
**Waltham, Mass.**

We have now successfully completed the development of the airborne automatic tracking Shoran reconnaissance system with recording camera. The equipment is in service test while production in quantity is under way. Automatic tracking replaces the prior manual system, reducing personnel requirements in the aircraft, at the same time improving accuracy. The development included a miniaturization program that succeeded well.

Also completed was the associated Straight Line Indicator, a mechanical analog and resolver to give aircraft positions in universally orientable rectangular coordinates, indicating deviations from flight along arbitrarily chosen straight lines. Mechanical accuracy of the equipment exceeds the basic accuracy of the Shoran range data received in your aircraft.

• I think that the great challenge of our industry (avionics) feels is the positive need to miniaturize, ruggedize, simplify and integrate as well as consolidate all electronic equipment the aircraft must carry.

**JOHN A. LAUCK**
**Vice President-Engineering**
**Pesco Products Div.,**
**Borg-Warner Corp.**

Our most significant contribution during the past year was the development of hydraulic pumps suitable for temperatures up to 400°F, in keeping with the trend to develop all component parts of aircraft and missiles to withstand extremely high temperatures.

We have also developed a method of keeping the skin temperature of an aircraft or missile to a safe operating temperature regardless of the ambient or frictional temperatures. And we have developed a jet fuel pump for operation of ambient temperatures of 300°F.

The most challenging problem to be faced is the question of finding the right materials to enable the component parts of an aircraft to operate at temperatures up to 600°F without malfunctioning.

Within the next 10 years we will pass from the jet to the atomic era in the aviation field; therefore, the prime movers in the aviation field will no doubt use atomic energy for this source of power. We are currently working on problems along this line which we cannot disclose at this time.

## *Instrumentation— and Test Equipment*

**JULIUS KENDALL**
**V. P.-Sales**
**Greer Hydraulics, Inc.**

For the past five years Greer Hydraulics has been working on the development of sufficiently reliable hydraulic component and accessory test equipment capable of providing a means of testing servos, servo controls and other type of hydraulic components required in aircraft and missiles for temperatures up to 375°F.

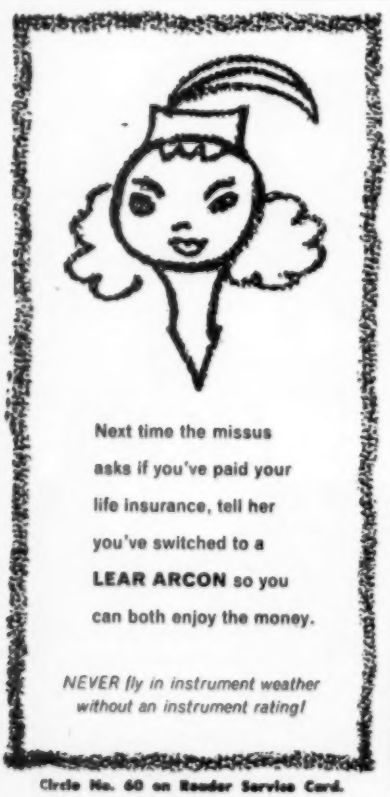
The accuracy of this equipment must be maintained within 1% and the reliability and repeatability must be within 2%. This problem is extremely accute due to the variables involved, such as temperature, flow and pressure, coupled to the accuracy of the many instruments, meters and gauges required.

With the increase in speed of aircraft and the use of non-inflammable hydraulic oils and synthetic fluids, the problem of having reliable, accurate test equipment for testing aircraft hydraulic components is of prime importance.

One of the most immediate problems still challenging the aviation industry insofar as test equipment is concerned is the standardization of testing procedures and the acceptance that test-equipment manufacturing is a business the same as the manufacturing of hydraulic components and aircraft, and that most companies manufacturing this equipment are reliable, so that the units built will satisfy the exacting testing requirements needed by the aviation industry.

Once this point is accepted the industry can proceed rapidly with more automatic methods employed in test equipment, coupled with the use of the analog and digital computers, to provide more accurate and quicker answers.

It is felt that within the next ten years test equipment will become more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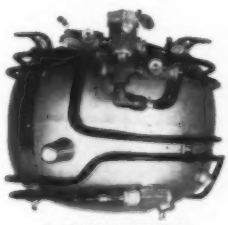
## IN OXYGEN EQUIPMENT

20 LITER CONVERTER



5 LITER CONVERTER

**ARO Liquid Oxygen Converters save space and weight . . .**

**make one tank of liquid do the job of many tanks of gaseous oxygen! This important forward step in oxygen supply is another ARO *first!***

In the specialized sphere of oxygen equipment and components for high altitude flight . . . aviation looks to ARO for leadership!

ARO research and development have pioneered and perfected many of the new products to control the vital oxygen supply for the men who fly "way upstairs." Leading aircraft makers depend on Aro for a growing number of precision products. For further details write:

**THE ARO EQUIPMENT CORPORATION**
**BRYAN AND CLEVELAND, OHIO**
*Aro Equipment of California, Los Angeles, Calif.*
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**ECTRICAL TRANSDUCER GAGING SYSTEM**

An IMPROVED means or measuring contents of Liquid Oxygen Converters . . . provides a continuous sight-reading of amount of liquid oxygen remaining in converter.

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**AIRCRAFT PRODUCTS**

**Liquid Oxygen Converters, Oxygen Regulators, Pressure Regulators, Contents Gauges, Relief Valves, "Anti-G" Valves, Air and Oxygen System Accessories, Actuating Cylinders and other Aircraft Accessories.**



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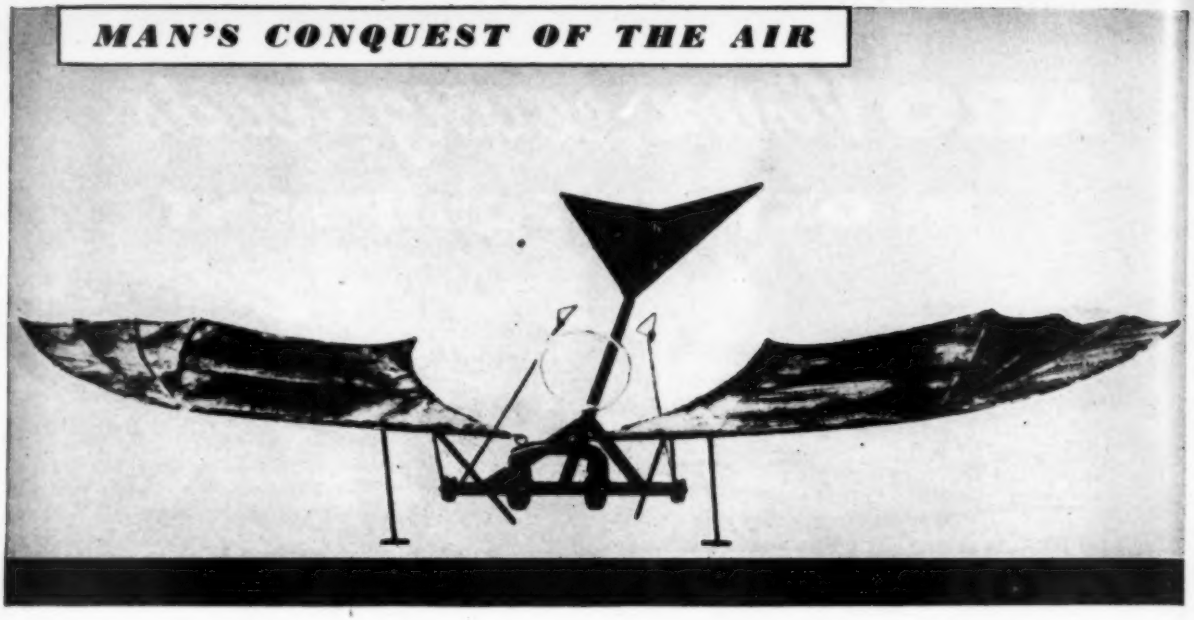
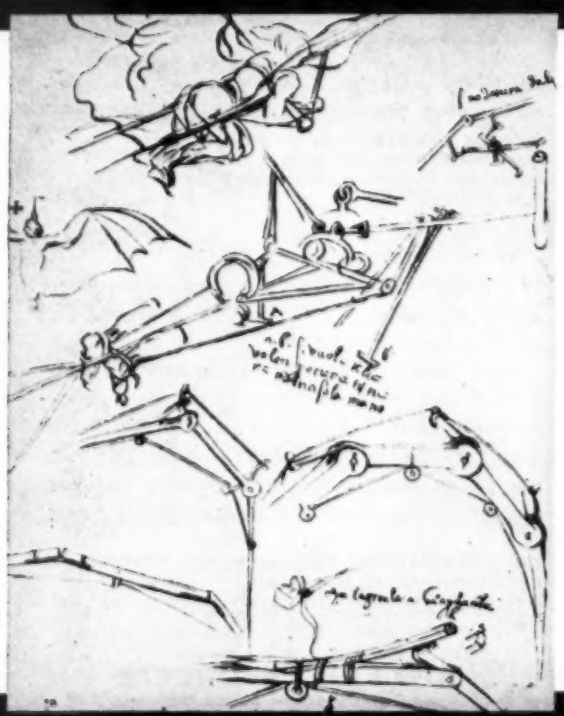
**MAN'S CONQUEST OF THE AIR**



# *First Plans for Mechanical Flight*



"If I find that this instrument made with a screw be well made — that is to say, made of linen of which the pores are stopped up with starch — and be turned swiftly, the said screw will make its spiral in the air and it will rise high."

These are not words of a visionary but the careful notes of the man who gave the world its first detailed plans for mechanical flight — Leonardo da Vinci. Over 400 years ago he made a careful scientific investigation of the mechanics of bird flight, planned in detail the helicopter and parachute, and constructed many test models of flying machines. Always seeking improvements, he died with his work unfinished.

"There shall be wings!" da Vinci declared. "If the accomplishment be not for me, 'tis for some other." Today we have those wings and like da Vinci, keep trying to improve the ways we fly. With the same spirit ESSO research continues to supply today's new and better aircraft with new and better aviation petroleum products.

**It pays to ask for**

**ESSO**

**INTERNATIONAL AVIATION PETROLEUM SERVICE**

automated, will require greater skills for its operations and will be more precise. Instrument and control manufacturers must be kept abreast of these items, since the test stand must be superior to the item being tested.

**R. L. SINK**
**Consolidated Engineering Corp.**

Most significant contributions to the industry during the year:

• Design, installation and operation of data handling and data processing equipment for rapid recovery of more precise measurements. A number of such installations were made.

• The release of precision magnetic tape recording equipment for gathering in-flight data.

Most challenging immediate problem is the need for further study to utilize more effectively the more precise and larger quantities of data made possible by systems similar to those described above.

The next decade will see improved (speed and accuracy) methods of measuring and utilizing the results of measurements in both test and service vehicles.

**V. C. WESTBERG**
**V. P., Director of Engineering and Research**
**Sun Electric Corp.**

As a testing equipment manufacturer, one of our major problems was to meet the increasing size of aircraft components with testing facilities of adequate capacity. Aircraft generators and alternators especially have increased three to four times in capacity recently.

Loading devices built into testers had been utilizing ceramic stick resistors of a limited capacity by parallel connections. With increasing requirements the stick resistor method resulted in a loading device that was costly, of considerable bulk, and with over 100 bus connections that were a possible source of trouble.

A loading device developed by Sun Electric reasearch to replace the stick resistor device weighs 15 pounds with a volume of ½ cu. ft. and has only six bus connections. The comparable load, built with stick resistors, weighs 100 pounds, occupies 12½ cu. ft., and has 100 bus connections.

The great saving in space, weight and material was accomplished by using unique cooling principles to remove the heat more efficiently by both radiation and combustion.

Maximum convection cooling was obtained by eliminating insulating ceramic coatings for direct metal-to-air heat exchange, plus utilizing a duct to direct ambient air to each turn of the resistor. By "V-forming" the resistor ribbon, a greater percentage of heat is radiated away from the load unit then occurs with the edge-wound element that radiates heat from one turn of the adjacent turns.

Projecting the trend in aircraft development into the future shows that the industry will require components and systems with greater capacities and with a higher degree of precision in operation. To keep abreast of this progress, testing equipment will have to be manufactured to higher standards of accuracies and capacities at present considered unobtainable or not economically feasible.

**P. H. NEEDHAM**
**Vice President**
**United Mfg. Co. Div.**
**W. L. Maxson Corp.**

One of United's most significant contributions to the aircraft and missile industry during the past year is the successful utilization of the feedback principle in testing aircraft alternators.

A synchronous machine rather than a load bank is used to load the test alternator. The synchronous machine is an aircraft alternator used as a motor. The electrical power flowing between the test alternator and the motor is a function of the phase angle between the two machines and is precisely controlled by physically rotating the stator of the motor with respect to the test alternator.

Power factor is controlled by varying the feed voltage applied to the motor. The motor feeds mechanical power back to the variable speed device employed to drive the test alternator. Protective devices, instrumentation and control are provided for the test alternator and also associated aircraft electrical power components.

Utilization of this system in preference to the conventional drive and load bank results in greatly reduced input power requirements, cost, weight and size.

**A. S. CLARKE**
**President**
**Nems-Clarke, Inc.**

The accelerated missile test programs now under way require ground-station telemetering receiving equipment with improved performance, particularly with respect to stability and adjacent-channel selectivity. Nems-Clarke, Inc., which has been one of the major suppliers of telemetering receivers, has developed, under contract with Philadelphia Ordnance District, an entirely new ground-station receiver, the specifications for which were evolved after consultation with many interested engineers at the various missile test facilities.

The receiver, which is now undergoing tests, is crystal-controlled and has two intermediate frequency amplifier systems—one a wide-band system with an "if" bandwidth of 500 kc for FM/FM telemetering service, the other "if" amplifier having a bandwidth of 100 kc intended primarily for pulse modulation systems.

The selectivity of the receiver is such that when the 500-kc "if" strip is being used, a signal 500 kc removed from the desired signal is attenuated at least 60 db. When the narrow-band "if" strip is in use, undesired signals 100 kc from the desired signal are attenuated at least 60 db. The carrier frequency range of the receiver is 216 mc to 247 mc. Noise figure is approximately 6 db anywhere in this frequency range. Image rejection is 50 db. "If" rejection is 80 db. Video amplifier bandwidth extends to 100 kc, and distortion is so low that it cannot be measured with available test equipment. The receiver sets a new standard for equipment of this character.

Nems-Clarke has also redesigned its previous line of special-purpose receivers to provide better electrical performance and stability. Several new receivers have been added to the line, which provide the ultimate low in noise figure with presently available tubes and embody many other features as well.

It's a small world,
but you can hit it if
you fly without a
LEAR ARCON.
NEVER fly in instrument weather without an instrument rating!
Circle No. 60 on Reader Service Card.

SAVE 10 LBS.* specify hi-shears

In weight comparison between HI-SHEARS and high strength close tolerance bolts, per thousand pieces and using a ¼" diameter—⅜ grip length—4650 lbs. shear, the bolt-nut-washer weight is almost double that of HI-SHEARS.

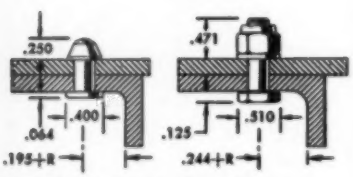
| | | |
|---|---|---|
| HS52P-8-6 | Steel Hi-Shear Pin | 9.25 |
| HS15-8 | Alum. Hi-Shear Collar | 1.32 |

10.57 lbs.

| | | |
|---|---|---|
| NAS464P4A7 | Steel Bolt | 17.35 |
| AN365D428 | Alum. Nut | 3.40 |
| AN960PD416L | Alum. Washer | .90 |

21.65 lbs.

Even substituting a 40% lighter titanium bolt for the steel bolt, the bolt-nut-washer combination is still heavier than the HI-SHEAR by 4.14 lbs. per thousand pieces.




Substantial weight savings are also gained by the use of smaller fittings through reduced clearances required by HI-SHEARS.

Write for additional HI-SHEAR data

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hi-shear RIVET TOOL COMPANY
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**RALPH E. BROWN**
**Vice Pres. & Director-Engineering**
**Genisco, Inc.**

Our company's most significant contribution during the past year is the Model C-181 rate-of-turn machine (range .005 deg./sec. to 1300 deg./sec.). Its attributes are: extremely wide range (250,000:1) through single control; ball-disc integrator drive which provides smooth rotation and constant angular velocity as infinitely variable rate control. It is now in use by virtually all major gyro manufacturers.

In our field the most challenging problem at the moment is concerned with elevated temperature transducers—i.e., linear motion, pressure and acceleration transducers to function within close limits at temperatures from 600 to 1,000°F.

The next 10 years may produce improved accelerometers and pressure transducers with large output signal suitable for severe environmental conditions of shock, vibration, acceleration and temperature.

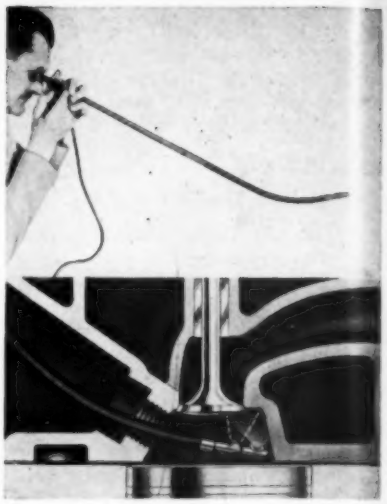
**L. STREIFENEDER**
**President**
**Eder Instrument Co.**

With our newly developed Inspectroscope, a much-needed device for internal inspection, it is possible to look around corners at any angle from zero to 90° and see a full, round image. This type of instrument is highly valuable to inspect intricate components of the aircraft industry. It has a long, flexible portion containing 77 optical lenses.

Prior to the development of this instrument, we marketed an Inspectroscope that accommodates an angle of 45°. (See photo.) This type of instrument is now used by Boeing, Pratt & Whitney, American Airlines and by the Wright-Patterson Air Force Base. It is also undergoing tests for further evaluation by the Naval Air Force in Hawaii.

The most important advancement in optical inspection, with this type of instrument, is that motors, wing sections, torpedoes or flying-missile objects can be visualized through a small opening without dismantling them in case of trouble. With an Inspectroscope, there is no necessity for taking some of the components apart.

Another instrument developed during the past year is a rigid Inspectroscope with a movable mirror at the ocular eyepiece, enabling the viewer to get extreme prograde to retrograde vision. Previously, four different instruments were necessary for the kind of inspection that can be accomplished with this instrument.



All of these instruments were developed primarily for the medical field but are now being made available for industrial inspection purposes in various fields.

**VICTOR SILBER**
**Partner**
**Special Machine Tool Engineering Works**

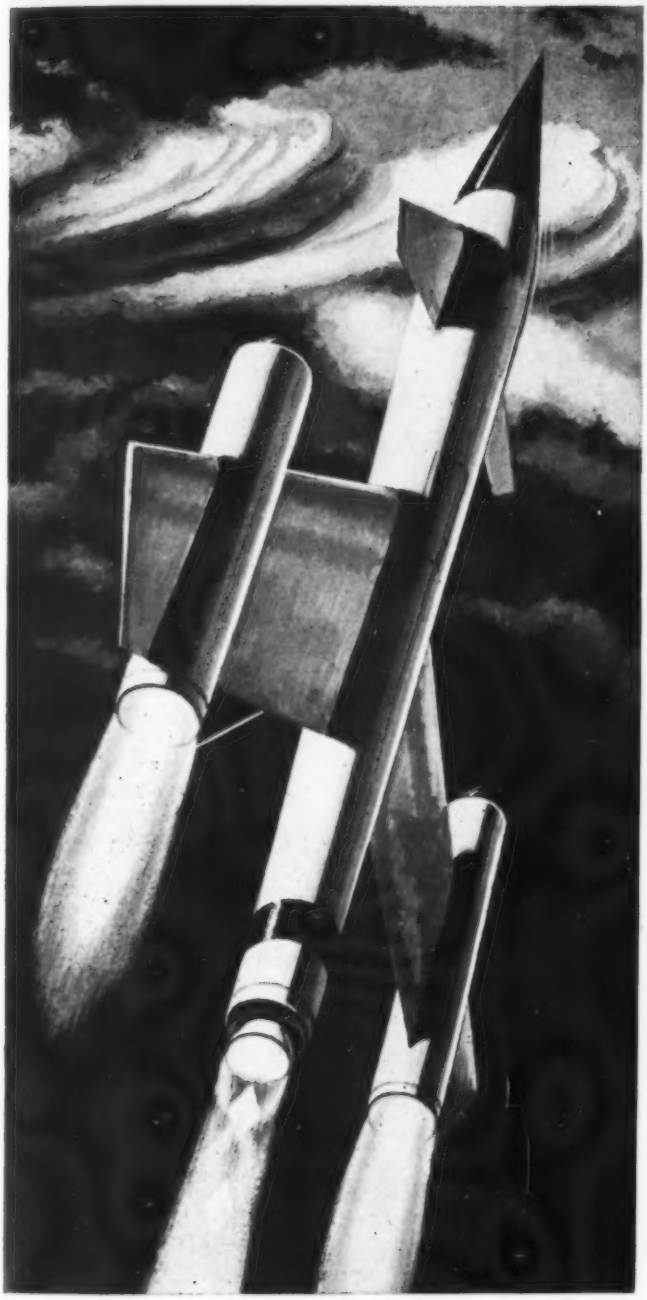
I am taking this opportunity of discussing a problem which, as far as I know, may not even be recognized. The problem: reducing rising cost of inspection. The solution: revise drafting methods of complement present AF inspection procedures.

For example, drawings do not distinguish between dimensions. Boundary dimensions, wear dimensions, clearance dimensions, etc., have the same degree of importance. Likewise, present inspection procedures do not distinguish between types of dimensions. If any are not within the tolerance of the blueprint, the inspector is required to reject the part. The inspection report then goes to material review, regardless of whether the discrepancy is important or relevant to the use of the part.

This procedure involves in itself a great deal of time and effort. In addition, there is very often a stoppage of work while the material review request is in process.

My experience is that a large percentage of these requests are on dimensions which are non-functional. The processing through material review is almost a complete waste on this type of dimension. Sampling procedures aggravate the problem. Judging from the costs in our plant, I would say that there is an opportunity to save hundreds of millions of dollars annually without loss of quality.

My approach would be to have



# a helping hand UP or OUT

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**Armament Jettisoning Developments by the Explosives Division of the OLIN MATHIESON CHEMICAL CORPORATION Have Proved to be Ideal Solutions to a Variety of Jet Age Problems.**

Many tough missile and aircraft problems have yielded to speedy solutions with the specialized aid provided by Olin Explosives Division experts. Recently, new developments by leading aircraft manufacturers have greatly been expedited by the unmatched knowledge and know-how Olin automatically places at the disposal of a manufacturer. If there is a possibility that any of your own problems can be answered through a creative utilization of solid propellants or explosives, a call to East Alton today may well prove an important step to a rapid solution.

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the designing engineer qualify all dimensions on the blueprint with quality control symbols. These symbols would specify quality control level and permissible deviation from drawing tolerances.

For example:

• **Type "A" dimension**—Could be passed by *inspector* if 20% or less are not more than 20% off tolerance. Inspection foreman could pass same parts if 50% were less than 20% off tolerance. Chief inspector could pass if 100% were less than 20% off tolerance.

• **Type "B" dimension**—Could be passed by *inspection foreman* if 20% are 20% off tolerance. Chief inspector could pass 50%.

• **Type "C" dimension**—Could be passed by *chief inspector* if 20% or less are not more than 20% off tolerance.

• **Type "D" dimension**—To Material Review Board only.

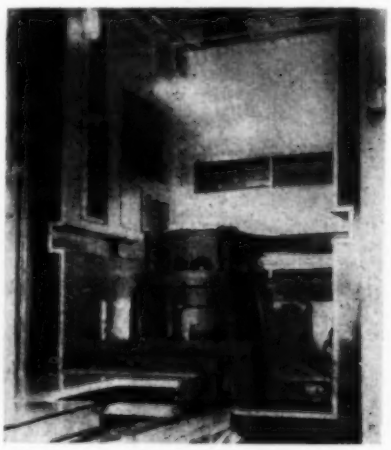
This is not by any means intended as a definite program, but merely as an indication of the lines along which I feel great progress can be made.

**KARL UNHOLTZ**
**Chief Engineer**
**MB Manufacturing Co.**

The development of a 7,000-pound force electrodynamic vibration exciter to operate inside an altitude environmental test chamber represents a significant contribution to the aircraft industry.

Operating a high-force vibration exciter inside an altitude chamber without imposing severe penalties on chamber or exciter performance raises difficult problems for the vibration test equipment designer. At chamber altitudes of 100,000 feet, air density and pressure render air cooling of the exciter virtually impossible and arc-over from electrical voltages within the exciter is a serious problem. To achieve chamber temperatures of —100° F, the exciter must not dissipate heat into chamber.

• **MB solved** these problems with a liquid-cooled vibration exciter. By transferring exciter heat to a liquid coolant and extracting this heat outside of the



test chamber, the heat dissipation problem is solved. The dielectric qualities of the liquid coolant eliminate electrical arc-over. Increased cooling efficiency also meant that the exciter could be made smaller than air-cooled exciters of equivalent force output. A smaller exciter saves premium space inside the test chamber and means increased exciter rigidity.

This development was entirely successful. Liquid cooling avoids the difficult and unreliable pressure-tight seals required for ducted forced air cooling. Furthermore, placing the exciter inside the chamber allows direct attachment of the test specimen to the exciter table and eliminates dynamic problems that arise when the specimen is driven by a long rod through the chamber wall.

• **The most challenging** problem facing the vibration test equipment designer is to develop a high-force (50,000-100,000 pounds), high-frequency (10,000 c/s) vibration exciter that will generate pure translational motion regardless of any interaction between the test specimen and exciter's moving table assembly.

Looking to the future, aircraft equipment and component design may well achieve a level of reliability heretofore unrealized when new vibration test procedures are incorporated into existing test specifications. Performing vibration tests with statistically controlled "random noise" inputs to the exciter that more nearly simulate the true vibration environment of aircraft structures may do much to reduce the safety factor and weight penalties that present-day specifications impose on aircraft design.

**DR. JOSEPH TAMPICO**
**V.P. & Dir. of Engineering**
**Associated Missile Products Corp.**

AMPCO, in operation only seven months, has turned out test equipment for missile programs of Northrop and Bendix. Our specialization as a source for missile support equipment is unique in American aviation.

Most immediate challenge is the design and fabrication of highly reliable "go no-go" missile test equipment that will be compatible with the level of training of service personnel and that will not burden the logistic systems of the armed forces with a heavy demand for specialized supplies.

The increasing trend toward semi- and fully automatic checkout of piloted and unmanned aircraft is apparent. The necessity of providing complex equipment of simple operation is obvious when it is realized that sufficient personnel of engineering capabilities are not available for routine testing functions.

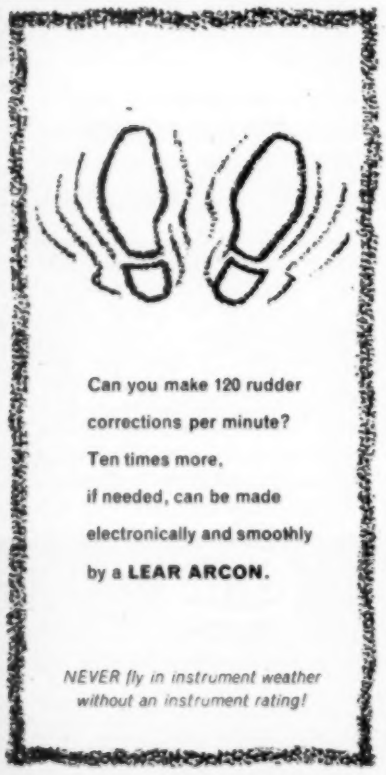
Further, subsequent testing operations will require far greater speed and volume capacity. The general effect of fuller testing facilities of an automatic nature will be to assure a tactical reliability of the piloted and unmanned aircraft which is almost equal to that obtained in manufacturing tests. Satisfactory results in such a development are obtainable in the next few years, provided sufficient funds are made available to develop equipment which is entirely specialized.

## *Aircraft Hardware*

**JAMES D. ANDERSON**
**Chief Engineer**
**Klincher Locknut Corp.**

For several years a major jet engine manufacturer has been troubled with variable temperature readings on terminal type thermocouples. It was found through extensive investigation that the majority of this error was due to the stainless steel locknuts being used on the thermocouple terminals.

Klincher Locknut Corp. obtained special drawn Alumel and Chromel "P" hex bars and produced free-running locknuts from the material. With these locknuts a complete homogeneous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if needed, can be made
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NEVER fly in instrument weather
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How can we meet these requirements? Well, our design experience is only *the most.* It includes Piston Plug Valves, Butterfly Valves, Sliding Gate Valves, Pressure Regulators. And you can have them solenoid actuated, motor actuated or pneumatically actuated.

The valve illustrated is our 35-079 Pressure Regulator, as supplied for the latest most powerful jet engines now in production. Write to Hydro-Aire for complete design data.

## hot air valves

*by*

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BURBANK, CALIFORNIA • *Aviation Subsidiary of* CRANE CO.

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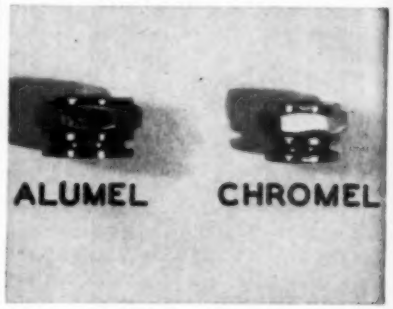
Alumel and Chromel thermocouple circuit was made possible; thus eliminating the majority of the temperature error.

The Klincher Free Running Locknut has two advantages over a prevailing torque type locknut on a thermocouple installation of this type:

• It is free running; thus having much less tendency to seize on the soft Alumel and Chromel studs at elevated temperatures.

• Being a free-running locknut, it




requires a specified amount of torque to lock it securely in place to assure a positive connection and a reliable reading. Yet if this locknut is not installed and torqued down properly, vibration will immediately break the thermocouple circuit which provides quick detection.

With an all Alumel and Chromel thermocouple circuit, temperature readings are much more reliable and accurate. This will permit a jet engine to be red-lined at a higher temperature (thus increasing the horsepower) and yet provide an equal factor of safety.

Klincher Free Running Alumel and Chromel locknuts will make it possible to receive better test results for evaluating new type of thermocouples.

**W. G. WALTERMIRE**
**Chief Product Engineer**
**Lamson & Sessions Co.**

There is a strong and growing need for information on the relationship of stud size, design elements and material with torque and other performance characteristics when driven in various materials with varying driving practices. We have led in research and constructive contributions in this field.

Most challenging of immediate problems is raising the shear and tensile strength of fasteners while also improving their ability to withstand increasing shock and vibration at increasing temperatures. This requires the production of brand new materials and successful solution of the problems of cold- and hot-heading them and of finishing them.

Technologically, our contribution to advancement of aviation in the next decade will be this:

As fastener shear strength and per-

# *The Most Trusted Name in Ignition*

## Pioneers in Development of Vibration-Resistant Electrical Connector

The unsatisfied demand for a rugged, dependable connector capable of meeting the exacting requirements of modern aircraft led the Scintilla Division of Bendix* to develop the *first* vibration-resistant electrical connector. These connectors using the revolutionary new insert material known as Scinflex were first used on Scintilla Division's ignition equipment for piston engines.

So outstanding was the performance of this new and better connector that its acceptance and use have now become world-wide. Today the Scintilla Division is a major contributor to the electrical connector industry.

This pioneering has never stopped. Bendix was first in the field with cadmium plated connectors, which were later made a requirement of military specifications. Our latest contribution is the best engineered closed entry socket contact available anywhere—one which cannot be mechanically overstressed.

*TRADE-MARK.

**SCINTILLA DIVISION**

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formance characteristics at elevated temperatures are increased, plane designers can raise the skin bearing allowables thereby permitting use of thicker skin of stronger material.

**DAVID A. GALONSKA**
**Senior Project Engineer**
**Saginaw Steering Gear Div.**
**General Motors Corp.**

It is my sincere belief that ball bearing screws have been one of the most important developments in the aircraft industry in the last few years because they solve so many problems formerly inherent in the design of actuators.

However, I think that one of the most important developments this year, publicly announced this summer, was our development of the Ball Bearing Spline. In any application where column length must change under torque load, our Ball Bearing Spline offers unprecedented freedom from the restrictions of conventional splines. It permits engineering designs hitherto impractical and is a "natural" for landing gear applications.

**CHARLES L. THERIEN**
**Engineering Dept.**
**Manco Mfg. Co.**

The aircraft industry today is striving to cut down resistance to obtain greater speeds. Flush-riveting is one way to achieve a part of this goal. To flush-rivet, it is necessary to dimple or form a countersink in the thin aluminum skins without upsetting the physical properties of the material.

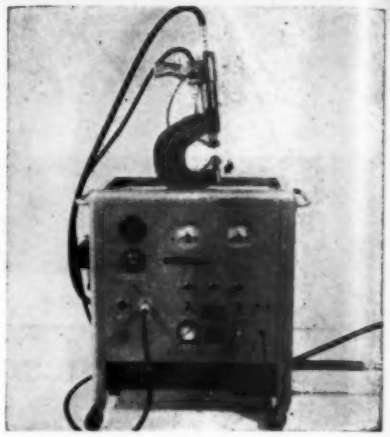
The new Manco hot-or-cold-dimpling unit can maintain a pre-determined heat pre-form and final-form setting to very close tolerance.

Thrust on the head itself for preforming can be infinitely adjusted over a range of from zero to 15,000 pounds. Timing to heat at any given pre-forming pressure can be adjusted from 0/15 seconds. Final-forming pressure necessary to give desired form is adjusted from 0 to 20,000 psi ram thrust.

Stock thickness of .020 through .102 ins. in 75S-T4 Alclad aluminum are being dimpled with a range of holes from ⅛ rivet-size through 3 8/16 screw-size with extreme accuracy as to size and heat control. The unit is self-contained and portable and packs more squeeze than any other known tool today.

•In our opinion a major problem to be faced in the aviation industry is the working of new materials brought out to combat the heat problem on aircraft that fly at supersonic speeds.

In the next 10 years, we hope to contribute smaller, lighter tools that



will do heavier work through the use of higher hydraulic pressures and the control of those high pressures.

**CHARLES C. FARONI**
**Chief Product Engineer**
**Elastic Stop Nut Corp. of America**

One of the most important developments of the past year was the release for production of a complete line of self-locking nuts to be manufactured from Type A286 stainless steel. As one of the so-called "Super-alloys" A286 has been available for some years, but it is a difficult material to machine and handle on the production line. Two years of development work got us over the worst hurdles, and these new parts are now available to the engine industry.

This is significant news because the combination of an A286 self-locking nut and bolt at 1,200°F is so much superior in terms of improved relaxation strength (and therefore, higher clamping force in the joint after temperature) that its performance is more than twice as good as earlier Type 347 stainless fasteners.

Alternately, A286 locknuts perform as well at 1,300°F temperature as those produced from 347 at 1,200°F. Because performance of the turbojet engine rises sharply in efficiency with higher operating temperatures, this is important news for designers. Higher tensile strength at 1,200°F also means that structure design using fewer load-carrying fasteners is now possible, with important weight savings obtainable.

• In the field of fasteners there are three broad problems that presently face us: 1) requirements by the engine industry for fasteners that will perform better at higher temperatures . . . with 2,000°F regarded as an ultimate possibility; 2) continuing demands from airframe and engine designers for lighter-weight fasteners; and 3) requirements for self-locking nuts able to carry greater tensile loads as high as 225 and 250,000 psi, which are a result of design trends like the very thin straight wings

now planned for Mach 2 and 3 airplanes.

• Our industry necessarily is concerned mostly with adaptation of some of the revolutionary developments in other basic material-producing industries such as metals and plastics. As new materials such as titanium, zirconium, thermoplastic or silicones are released, our assignment is to find the methods and designs which will bring their advantages to our customers in usable forms.

**ROBERT P. SCOTT**
**Brown-Line Corp.**

The development of track and fitting setups and their versatility for high density seating, gallies, partitioning, cargo tie down and stowage has been Brown-Line's significant contribution to the aircraft industry during the past year. One major problem has been the perfection of a new low-weight, high load capacity webbing for cargo and missile tie-down equipment. At the present time Brown-Line has developed tie-down equipment based on nylon webbing with a load capacity of 20,000 pounds.

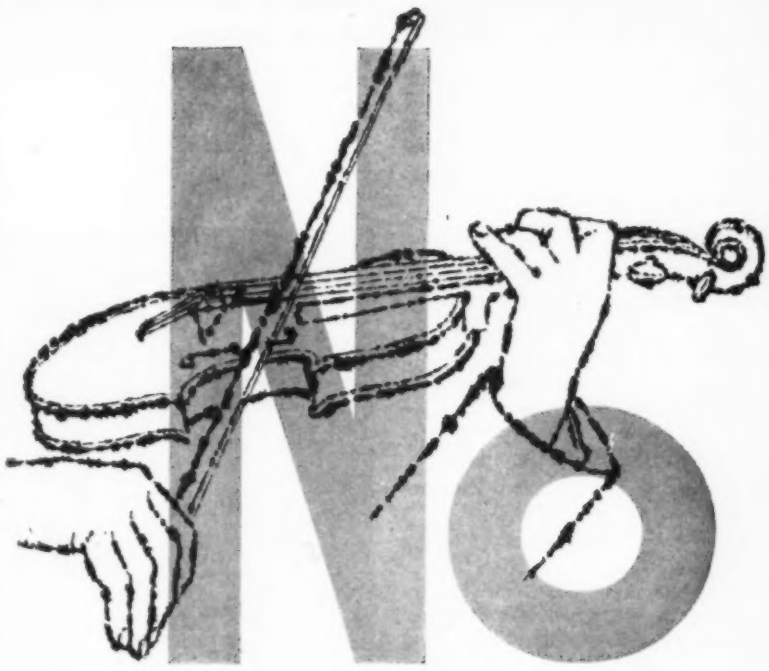
The most challenging of immediate problems still to be solved is convertibility of aircraft. Brown-Line believes the development of aircraft with more versatility for military and commercial uses and with more design thought to cargo conversion and handling is of great importance. In the overall thinking, the development of equipment for easy and quick convertibility of planes from passenger to cargo to litter to tanker, etc., is a challenging problem in our field.

Contributions in our field that may be evolved in the next 10 years are (1) the design of more efficient methods of cargo and payload handling, such as the use of load pallets, for more efficient loading and unloading with less personnel; and (2) the development of lighter cargo load control equipment which can handle higher G loads.

**WALTER G. MITCHELL**
**Director-Engineering**
**Thor Power Tool Co.**

Automated assembly of screw fastened components on a high production, quality controlled basis, was established as a highly practical process this year. The development of new specialized pneumatic screw fastening equipment now makes quantity precision assembly practical in the same manner that machine tool transfer equipment makes quantity machining processes accurate.

A problem still to be faced is the establishment of a much more precise measurement of surface pressure be-

**no violin music**

The demand exceeds the supply. It's that simple!

With 3 engineering jobs available for every 2 engineers, some 5,000 companies are bidding for you with offers, inducements and background music. But don't be mistaken! Most of today's "opportunities" are *jobs*, not futures.

We, too, want engineers. But we're offering no violin music—only the opportunity for intelligent and careful evaluation—you of us and we of you—with the possibility of your joining one of the finest team operations in the whole new world of flight systems development.

Most of the people on that team are young, and moving ahead fast. They weren't lured here. They found out—and figured out—for themselves. We hope you'll do that too.

Contact J. M. Hollyday, Dept. AA-10, The Martin Company, Baltimore 3, Maryland.

**MARTIN**
BALTIMORE

tween assembled adjacent surfaces. The torque measurement of screw fastenings yields merely a relationship connected with the tightness of joints rather than a true measure of surface to surface pressure.

Developments that may take place in this field during the next 10 years are improved methods of securing controlled quality in production process and improved, simplified control and power units of broad applicability.

**R. E. SEARS**
**Vice President-Engineering**
**Beaver Precision Products, Inc.**

In my opinion the most challenging of the immediate problems still to be faced is the development of ballscrews to operate at 500° to 1000° F.

**EIVIND H. GUNDERSEN**
**Research and Development Engineer**
**Pheoll Manufacturing Co.**
**Aviation Div.**

Development of Pheoll Hi-Shear Rivets in titanium, A-286, and Haynes 25, as well as other materials, has been a primary achievement of our company during the past year. An upcoming problem in our field is development of high strength fasteners for high temperature applications. Such fasteners will be a determining factor in aviation progress.

The CAA reports that 561 stall-spin accidents occurred in 1954. Naturally not a single one of these planes was equipped with a **LEAR ARCON.**

*NEVER fly in instrument weather without an instrument rating!*

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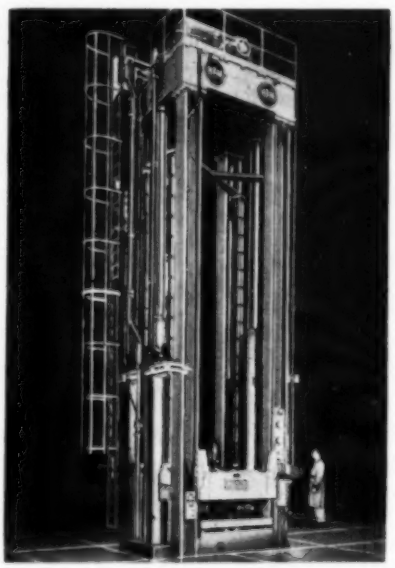
## *Materials — Processes*

**MILTON BRUCKER**
**President**
**Zenith Aircraft**
**Div. of Zenith Plastics Co.**

Zenith Aircraft, Division of Zenith Plastics Co., is primarily interested in the design, development, fabrication



and test of components for aircraft and guided missiles. These components, constructed from reinforced plastics, are required to withstand increasingly higher stresses and temperatures imposed by transonic and supersonic flight.

Within the past year, Zenith has acquired valuable facilities for commercial-scale production of the critical components required by military and civilian airframe manufacturers. One of the major facilities installed is the world's largest press exclusively designed for the fabrication of reinforced plastic parts.

This machine, built by the Hydraulic Press Manufacturing Co., is a 600-ton device, with platens 75 by 105 inches and 27 feet of daylight-clear opening. Designed to handle readily parts as long as nine feet, the press weighs about a million pounds, extending 43 feet into the air from a base 28 feet below ground level. Total height is thus approximately 71 feet.

As previously stated, the greatest challenge of the growing aircraft industry to our field of work is the temperature problem. The constant improvement of basic materials, plus continued effort toward development of new techniques, design procedures and knowledge of variables concomitant with advanced molding methods, all contribute toward an eventual increase in the use of reinforced plastics in piloted and pilotless aircraft and guided missiles.

It is our belief that the reinforced plastics industry eventually will be in a position to mold complete structures and airframes for aircraft and missiles satisfactorily. There can be no question but what these improvements will lead to an inevitable large reduction in cost of assemblies and sub-assemblies, with accompanying increase in rates of production, uniformity of parts and closer quality control, and with less use of critical manpower, factory space and unobtainable materials.

**KEITH R. WHITCOMB**
**Technical Director**
**Cee-Bee Chemical Co., Inc.**

The ever-present problem of stripping paint, primer and specialized coatings from rejected parts and phototemplates in aircraft manufacturing plants has recently been solved through the use of Cee-Bee R-48B. This is a liquid material that is used full strength

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AMERICAN AVIATION published bi-weekly at Harrisburg, Pennsylvania, for September 30, 1955.

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Wayne W. Parrish, Washington, D. C.; Editor, Wayne W. Parrish, Washington, D. C.; Managing Editor, Albert W. Bentz, Washington, D. C.; Business Manager, Leonard Eiserer, Washington, D. C.

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3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholders or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 33,250.

LEONARD EISERER
(Signature of business manager)

Sworn to and subscribed before me this 3rd day of October, 1955.

J. RUSSELL SHEFFER,
Notary Public.

(My commission expires March 9, 1958)

"Although the Roc carried me safely from a desert isle to a land of cities, I would rather fly, with greater speed and comfort, in a plane with repair and overhaul in the hands of SPARTAN. This company's work is truly magical and their shops are located in the center of a great and fertile land whereto the journey is easy from all parts of this wonderful country."

Even out-of-this-world travelers, like Sindbad, know that SPARTAN does every type of repair and overhaul needed in modern aviation and their work is solid as a "Roc." Aircraft may be flown in, arrive by train or truck or completely disassembled in crates. The SPARTAN sheet metal shop rebuilds any part of the airframe while other departments take care of the engines, propellers, instruments, radios and accessories. To you, this means the entire job moves faster because no part of the work has to wait on others. Discuss your aircraft repair and overhaul requirements with us by telephone, telegram, letter or fly in, anytime.

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and operates at a temperature of 180°F.

The stripping time on zinc chromate primer panels has been reduced from a 45-minute soak required with previously used alkaline strippers to a 3-to 5-minute soak followed by a water rinse. The heavy coatings on phototemplates can be removed in a matter of 30 minutes' soaking. Furthermore, anodized panels that have been primed or painted on one side only can be safely stripped in Cee-Bee R-48B.

•During the past three years the Cee-Bee Chemical Co. has been experimenting with a process designed to clean aircraft engines internally at period intervals during their service with the intention of increasing the service life and reliability of performance of these engines.

To date, several full-term Pratt & Whitney R2000 engines have been cleaned on test stands and disassembled for inspection. The results of this inspection were encouraging enough to warrant the cleaning of some engines on a periodic basis.

Recently we completed running of an R2800 engine for a commercial air carrier in which the engine was cleaned at approximately 250-hour intervals and was removed at 1,100 hours of service.

This engine will be disassembled for inspection in the very near future and, although the results of this test are not complete, the response of shifting from low blower to high blower was reduced from the 20 to 30 seconds required prior to each internal cleaning time to two or three seconds after the internal cleaning, indicating that the use of this cleaning method is effective in the removing of sludge deposits from critical areas.

This process uses a specially designed machine which circulates mixtures of Cee-Bee R-49 and engine oil through the aircraft engine while it is run-up on the ground for 30 minutes. This 30-minute cleaning operation is followed by a 10-minute flush with clean engine oil.

The results of this process to date offer high hopes for increasing the usable service life of an aircraft engine between overhauls and reduces the incidence of unscheduled removals of aircraft engines between overhauls.

The IF in IFR means you have a better chance of getting through IF you have a **LEAR ARCON.**

*NEVER fly in instrument weather without an instrument rating!*

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**T. A. KAUPPI**
**Manager-Product Engineering & Development**
**Dow Corning Corp.**

The development of resinous and rubbery silicone materials that retain their physical and dielectric properties at temperatures ranging from —150° to 600°F for silicone rubber and from —150° to 1500°F for resinous silicones has been our most significant contribution to the aircraft and missile industry.

Aircraft and missile development has, in the past, been limited by the inability of most material to withstand temperatures encountered at high altitudes and supersonic speeds.

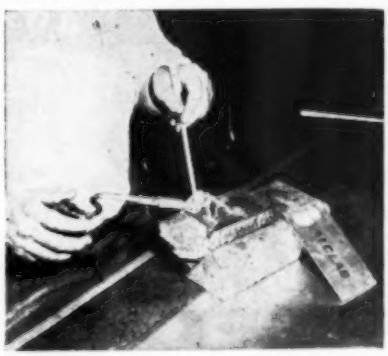
Representative of the success achieved during the past year are: (1) the development of a silicone molding compound that serves as a thermal barrier to reduce temperatures from 1500° to 500°F and (2) the use of Silastic seals on all access openings on the B-47. Moldings of Dow Corning 301 Compound are used as a thermal barrier for the brake shoes made for the Boeing B-52 by the B. F. Goodrich Co. More continuous braking on these heavy bombers, impossible without an adequate heat barrier, permits lighter strut construction. Other potential applications include cable supports, connectors, brush holders and core forms.

• Our major problems are: (1) the development of silicone rubbers that will withstand still higher temperatures for short periods of time, the perfection of self-extinguishing and more oil-resistant silicone rubber stocks, and (2) improvement of resinous silicone products by incorporating greater physical strength at high temperatures.

We expect to develop silicone rubber stocks with greater physical strength and with thermal stability comparable to or superior to the best stocks now available. We also expect to make available silicone resins that can be expanded at room temperature to form heat-stable, low-density solids for such application as thermal insulation, barrier walls, radome and cover hatches.

**SAMUEL FREEDMAN**
**President and Gen. Mgr.**
**Chemalloy Electronics Corp.**

In the field of electronics, we have advanced the art of microwave calorimetry to measure microwave radar power between 1,000 and 40,000 megacycles to an accuracy of 2% instead of two decibels. About 50% of American and Canadian industrial firms and government activities have now adopted it. In the field of metals, we have developed Chemalloy fluxless low temperature aluminum solder and welding rod which can be applied and fused at about 1/3 the disintegrating point of aluminum. About 900 organizations have now made preliminary use of this development. It has been accomplished by making zinc and lead homogenous.



The use of low temperature fluxless joining materials by soldering or welding techniques to replace rivets is the most challenging problem facing us now. We are positive it can be accomplished, if only past experiences and notions can be set aside momentarily to try it.

• **Looking toward the future** in electronics we now have the fail-safe communication system which will increase radio circuit capacity 300% by eliminating replies or acknowledgment plus human delay in conducting two-way voice. This is accomplished by making the entire transmitter, the local oscillator of the receiver, and each change in intermediate frequency a separate channel of control or communication.

If you hear yourself talk, or if light or annunciator comes on when you transmit, then it must have reached the other end intelligibly since it repeated back from there intelligibly to you.

We have 22 programs of development and product engineering in elec-

# Yardney SILVERCEL® batteries enable YOU to OVERPOWER OLD CONCEPTS

It makes little difference whether energy is needed for telemetry, instrument packs, servos or overall power. Wherever weight, space and severe current drains are critically important, Yardney Silvercels® solve the power problem.

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High-rate Silvercels® in capacities as small as 1/10 amp-hour.
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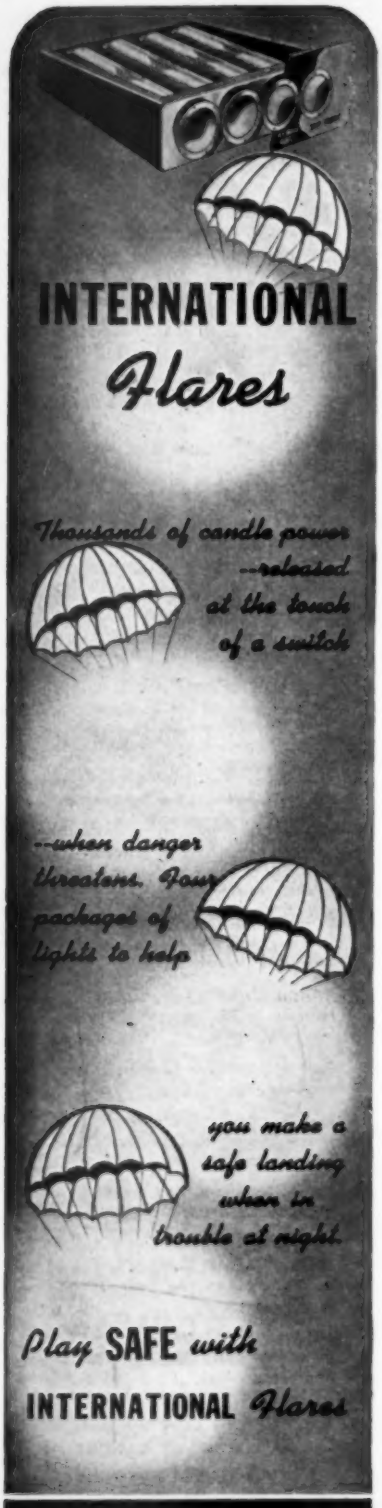
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tronics and metals. Some of our programs for the early future include:

• **Midar** instead of radar to give zero minimum range and to be an attachment to existing radars to cover local blanked out range. Thus radar will be free to operate for greater ranges by being kept at maximum sensitivity even though this normally paralyzes local range reception.

• **The Chemalloy battery** — By blending zinc with other metals, particularly lead, normally incompatible, with muriatic acid, we can get zinc to accept up to 18% lead in combination; this is also true of other metals. Such metal in powdered grain form yields .6 volts in a drop of water. A pound of this metal representing 10,000 grains or more can make up that number of batteries of .6 volts each. This battery, with respect to a period of several years (tested 4½ years now) is perpetual when metal comes in contact with liquid. It is inert when liquid is absent. The metal does not consume itself; the liquid does. I predict new simple forms of electrical energy.

• **Dry bearing metals** that are heatless, frictionless and lubeless.

• **Tuned microwave reflectors** to increase radar performance 313.6 times at 10 miles' range, more for greater distances, less for shorter distances by giving a finite reflector and finite wavelength the efficiency of a mirror and beam of light (infinite plane and infinitesimal wavelength).

• **Chemical generation of** alternating current and radio frequencies by conversion of static bipolar dc into dynamic condition.

• **(a) Continued elimination** of wires and conductors and the substitution of displacement concepts where waveguide pipes replace all the elements of an electrical or radio circuit by their size, shape and design. **(b) The derivation** of these shapes to critical tolerances with respect to the operating wavelength by the use of the shell molding process. (In January 1955, we successfully completed the first contract for the U. S. government in large quantity for such components derived of aluminum cast complete with flanges.)

**J. H. DuBOIS**
**V. P.-Engineering**
**Mycalex Corp. of America**

Our most significant contribution to the aircraft and missile industry during the past year is the first commercial production of "Synthamica" synthetic mica.

Snythetic mica offers much higher thermal endurance than natural mica and our "Supramica" ceramoplastic materials provide molded and fabricated products with thermal endurance up to 1,000°F, combined with total dimensional stability, low electrical loss, high dielectric strength, high arc resistance, thermal expansion coefficient that matches steel, zero moisture absorption and radiation resistance.

We are in production on Supramica 500 and Supramica 555 and have already supplied products for many critical aviation applications. An experimental radome of Supramica 555 has been molded and is now under test.

Our most challenging problem is to reduce weight and improve the strength of these high temperature materials.

• Technological contributions that we will make of revolutionary character during the next 10 years will include large area sheets of recrystallized Synthamica. This is done to make the aircraft industry independent of foreign sources of supply. These new synthetic mica products will permit higher temperature operation of electrical devices. When you double the temperature endurance of a motor or generator, its output is tripled.

**JOHN B. SCHNELLER**
**President**
**Duracote Corp.**

Our most significant contribution to the industry the past year was the further development, advancement—

and acceptance in both commercial and military aircraft—of our line of interior trim fabrics with Fiberglas cloth backing (our Dura-Trim line) for headlining, wainscoting and covering of sidewalls, hat racks and bulkheads.

The major problem which has heretofore confronted operator and manu-



ricators encountered problems in appli-

increase control in production and also to predict properties obtainable. As a

cations. At present Mallory-Sharon is producing successfully a number of

facturer alike is the change in dimension of interior fabrics with change in atmospheric humidity conditions, causing alternately taut and "sagging" headliners, wrinkled bulkhead coverings and so forth. Dimensionally stable Fiberglas backing has enabled Dura-Trim to overcome these problems.

To this, one can add the companion features of this Dura-Trim development—features provided by Fiberglas—in terms of lighter weight with equivalent or greater strength and puncture resistance, maintaining of light weight because of backing being non-absorptive, greater fire resistance. Other fabrics using organic backing cloth fail totally from a dimensional stability standpoint, and are without or short as far as other features are concerned.

Biggest immediate problem is simplification of installation of interior appointments—principally headlining—by way of materials and/or fastening processes or procedures.

Through projects now under consideration, it is felt that we may quite likely achieve that aim within the next year or two.

**H. H. BRAM**
**Metallurgical Chemist**
**Bram Chemical Co.**

We have met perplexing technical problems relating to made-to-specifications non-ferrous metals, alloys, minerals, chemicals, salts and compounds for use in the electronics and atomic energy research laboratories, as well as for the aircraft industry in general.

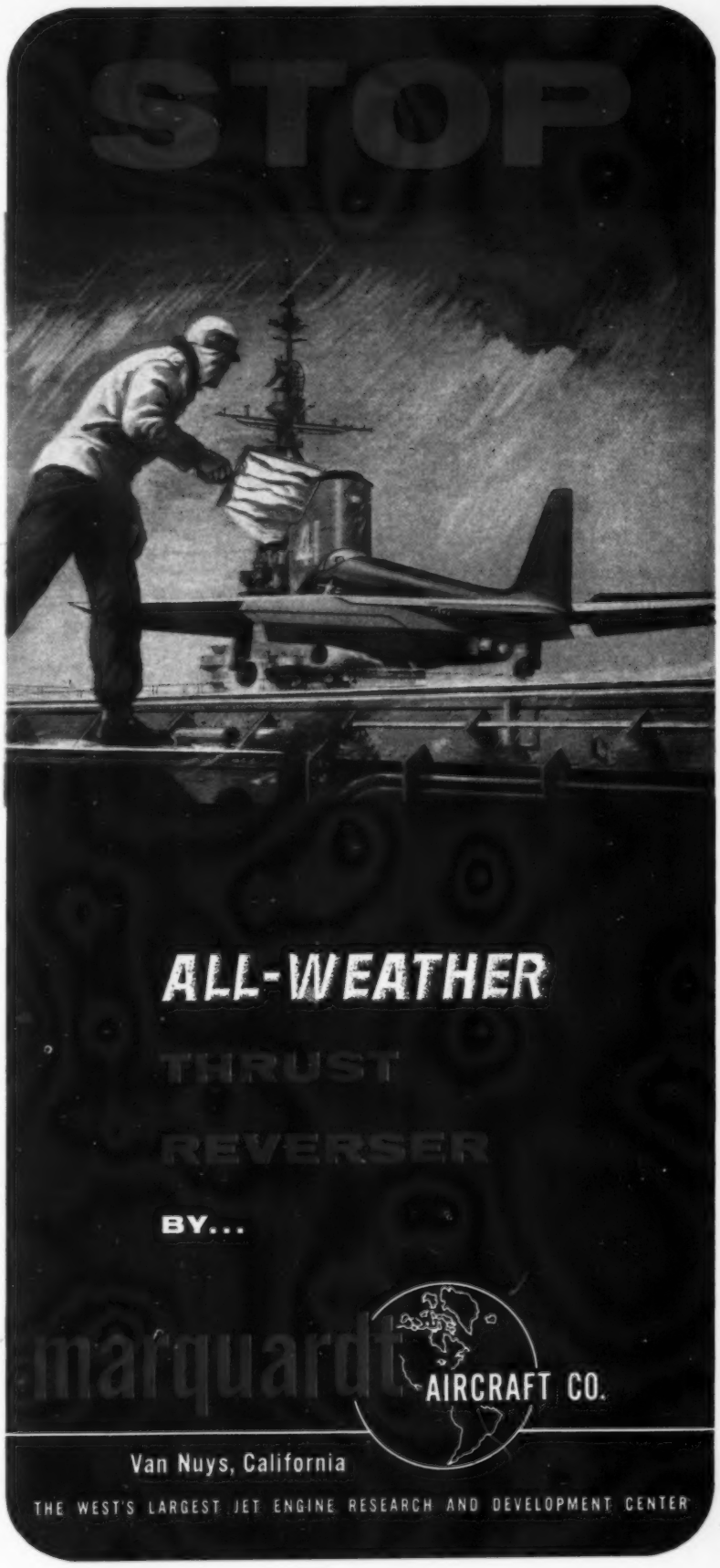
Far greater advances are being made now than a year ago by reason of high-level experience, consultations and improved end-results, particularly regarding rare metal alloys, compounds and salts.

The most challenging immediate problem we face concerns the projected potentialities of atomic energy.

Such technological contributions as we may make within the next ten years probably will be chiefly in the field of atomic energy and its power potentialities.

**BURT H. McKIBBEN**
**Chief Metallurgist**
**Mallory-Sharon Titanium Corp.**

The most significant advance in titanium lies in greatly improved quality standards, compared to even 12 months ago. This advance is significant for the reason that variations in strength, and other characteristics, have been stumbling blocks to faster adoption of titanium. Aircraft designers were understandably reluctant to incorporate titanium when quality was uncertain; fab-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serves. Information sent from selling

It also facilitates the analysis and com-

For an effective system, the spacing

ricators encountered problems in application of the metal.

As one example of the increase in quality, Mallory-Sharon is now guaranteeing that all its titanium mill products have a maximum of 0.1% carbon. This guarantee, made possible by "Method S" vacuum double melting, means that machining time can be reduced, and production rates increased. Carbon solubility in titanium is approximately 0.2%, and larger percentages result in the formation of hard carbides which greatly reduce machineability.

• An even more important contribution has been the application of statistical quality control techniques to titanium production. This has helped us increase control in production and also to predict properties obtainable. As a result, we now certify mechanical properties of a given heat within narrow limits of a certified average. This again helps fabricators by eliminating segregation of incoming sheet material and multiple tooling setups for titanium of different strength level groups.

This is proof of a dramatic improvement in titanium quality standards, and we can say today that quality levels fully meet the rigid requirements of the aircraft industry, which must have this metal to build air superiority.

• The most challenging of the immediate problems is to develop the exactly right materials for specific applications. At present Mallory-Sharon is producing successfully a number of alloyed grades in rods, bars and forgings, and we have applied titanium alloys to sheets.

A new alloy introduced commercially this year, MST 6 A1-4 V, has overcome the problem of elevated temperature embrittlement. This alloy, which exhibits excellent strength and stability up to 750°F, shows how the search for new materials can fulfill specific needs.

Titanium has merely scratched the surface of its possible applications in aircraft. For the faster aircraft of tomorrow it is a necessity. In commercial transports too, which will fly at the speeds of military aircraft today, titanium will be required both from a performance and economy standpoint.

**WILLIAM D. BRIGGS**
**Aircraft Process Engineer**
**Turco Products, Inc.**

Our most significant development is in the field of jet engine cleaning and inspection. Previous mechanical cleaning procedures used to remove the obdurate heat scale and oxide deposits from the hot sections of jet engines resulted in obscuring defects. This caused an abnormally high rate of failure when engines were turned up after overhaul. The chemical procedure developed by Turco Products yields a clean part which can easily be inspected by dye penetrant inspection methods (the alloys involved are non-magnetic) with a resulting decrease in rate of failure.

We regard surface preparation of various alloys prior to metal bonding as the most challenging problem still to be faced in our area of the aviation industry.

The technological contribution of a revolutionary nature that our field will have on aviation during the next ten years will be the development of materials and equipment to mechanize engine cleaning further during overhaul.

## *General*

**S. J. SINDEBAND**
**President**
**The Teleregister Corp.**

Our most significant contribution to the aviation industry during the past year is the adaptation of our Magnetronic Reservisor System to teletype input in the case of Braniff International Airways. Principal requirements were utmost reliability, speed and the economy of utilizing an existing teletype communications network to tie in central electronic data processing storage equipment with all cities the airline

*and so is dual omni!*

When you're doubly geared for action, any job can be made *twice* as easy . . . and dual ARC Omni installations double flight efficiency, increase the pilot's confidence in navigation. With dual omni 15D equipment, a single pilot can make a fix *faster* . . . he can fly any omni track while also cross-checking for position. It's easier to make transition from omni to runway localizers.

With two pilots, the work can be shared for greater ease, by using both omni instruments simultaneously for different jobs.

ARC 15D Omni is compact, lightweight, CAA certified, and now employs new course indicator which combines course selector and cross-pointer meter in a single space-saving unit.

Lighten the load with ARC DUAL omni. Data on request.

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serves. Information sent from selling locations by teletype transmitter modifies the seat count inventory maintained on a magnetic drum in Dallas.

The most challenging problem in our area of the aviation industry is the integrating of the principal reservation functions, i.e. determining availability of space, recording reservations by passenger name and issuance of tickets for processing by a single electronic system.

Within the next 10 years we see the probability of handling all reservations, inventory records and billing by fast, economical, electronic means. In the case of even an international airline, the processing will all be done at a single central point, with the information flowing in from the remote points by wire and radio.

**PROF. DONNELL W. DUTTON**
**Director-Engineering & Development**
**Winder Aircraft Corp.—Lakeland Div.**

Our firm has been for some time working on the development of a new type of helicopter. In this connection, it has been our desire to design a new commercial helicopter that could be modified for military usage by the armed forces. We have always felt that there is a definite need and place for such a helicopter and that the commercial possibilities are unlimited.

In addition to the above research and development program, the Winder Aircraft Corp. has been for a number of years prime contractors of electronic equipment to the Army, Navy and Air Force. In producing these contracts on schedule, there have been a number of engineering problems involving aspects of procurability and producibility.

**H. A. VAN DUSEN, JR.**
**Design Engineer**

**P. B. CLARK**
**Product Section Engineer**
**Line Material Co.**

A procedure has been developed for analyzing, by a mathematical and graphical process, the effectiveness of various runway and approach lighting configurations. This is a three-dimensional process which takes into account such variables as weather conditions, cockpit cutoff (limitation of the pilot's view due to the windshield configuration etc.), and the effects due to the aircraft not being exactly on the prescribed approach path.

The results of this process appear as a perspective illustration representing the view that a pilot sees during his approach to the runway.

This procedure of analyzing airport lighting configurations enables the introduction of a great many variables. It also facilitates the analysis and comparison of a large number of systems, whereas the usual procedure, requiring an actual test installation at tremendous dollar and time expense, prevents extensive tests and comparisons.

To date, the mathematical and graphical procedure has been useful for evaluating and disclosing the faults of several theoretical approach lighting systems. In addition, this procedure has shown that runway lighting, using conventional high-intensity runway lights, can be made effective under very poor weather conditions, such as ⅛- and ¼-mile visibilities.

For an effective system, the spacing of the lighting units would have to be 100 feet, instead of the normal 200 feet, along several thousand feet of the approach end of the runway.

• The most challenging problem in airport lighting at present is the development of an approach lighting system that will be effective in weather of very low visibilities. This is not only a problem of supplying higher candlepower intensities, but also one of attaining a system that will provide positive guidance to the pilot even when he can see only a portion of the approach lighting system.

*with ARC's NEW CD-1 Course Director*

Now there's no need to sweat out ILS approaches or fight to maintain OMNI tracks! ARC's new Course Director automatically directs the pilot to the correct headings required for effectively intercepting and making good a desired track. Heart of the system, the Compass Slaved Directional Gyro, gives constantly corrected directional information. System is accurate to one degree.

Computer portion of the system combines directional and track information obtained from the Localizer/OMNI Receiver and makes computations to provide the pilot with correct heading to intercept and/or make good a desired track, compensates for cross-wind. It relieves the pilot of 90% of his mental effort, prevents missed ILS approaches, saves time, effort and fuel, assures greater safety. Ask your dealer for complete information.

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One other consideration is that a pilot must be able to distinguish quickly and positively approach lights from the runway lights.

It is felt that the mathematical process will be of considerable aid in development of effective approach lighting systems.

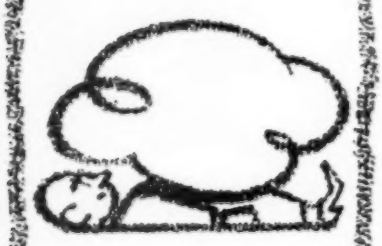
• It is very possible that in the future ultra-high frequency radio will play a larger part in providing guidance to landing aircraft. The recently announced development of the flat, transparent cathode ray tube that can be used as the windshield of an aircraft makes it feasible to present to the pilot an image of the runway lights or beacons exactly as they appear in clear weather.

**R. H. PREWITT**
**Engineering Manager**
**Prewitt Aircraft Co.**

During the past year, studies have been completed on helicopter and rotor blade vibration as inter-related. The end result of this study will be the production of aerodynamically contoured molded rotor blades matched to the helicopter to eliminate vibration.

The most challenging problem in the helicopter industry is the production of a commercial helicopter at a price permitting competitive transport operation.

The development of the vertical or direct takeoff and landing of highspeed aircraft machines will revolutionize the present air transport industry. ◈◈◈

A blanket of fog needn't turn into a shroud. Equip your plane with a **LEAR ARCON.**

*NEVER fly in instrument weather without an instrument rating!*

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# West Coast Talk . . . By Fred S. Hunter

**• Hughes' Flying Boat still must fly.**

**• Sonic boom causes panic in 'Frisco.**

WHERE were you on November 2, 1947? If you were Howard Hughes, you were making the first public demonstration of the huge Hughes flying boat in Long Beach Harbor. It was, incidentally, a most spectacular show.

Over the intervening eight years, the boat has remained in its Terminal Island hangar waiting for Hughes to take it out again. It suffered heavy damages when a dike broke and it was flooded with mud and debris. But these have been repaired. The big plane is ready to fly whenever Hughes says the word.

Hunter

It has generally been accepted that the flying boat's first flight also took place on that November day in 1947. In taxiing the big job around the bay, Hughes lifted it off the water for a forward skip through the air.

But what constitutes a first flight? Test pilots invariably get in some taxi hopping in making exploratory ground runs with new airplanes. But no one counts them as first flights. It's a first flight when a pattern is completed. In other words, the plane has to take off, go around and land. Under this interpretation, first flight of the Hughes boat still is to come up. And when, eventually, it does come up, you can expect Howard Hughes to make it a good show.

• •

Panic in the streets. This was the headline on a newspaper account of a recent mysterious explosion in San Francisco. There was no trace of its origin. Authorities concluded it must have been a sonic boom created by an unidentified aircraft.

The sonic boom is one of the complications of supersonic flight. With supersonic flight expanding, the Air Force is trying hard to prevent the sonic boom problem from increasing in proportion, and it is making good progress in that direction. Here are some of the flight rules pilots flying supersonic aircraft are asked to observe:

1. Avoid supersonic flight within 30 miles of populated areas, especially if you are losing altitude, and are heading toward the area.

2. Avoid supersonic flight below 40,000 feet. If supersonic dives are necessary, slow to subsonic speed before reaching 20,000 feet. You'll still set off a pretty loud boom, but probably won't break any windows.

3. Avoid supersonic flight within 5,000 feet of other aircraft.

4. Familiarize yourself with the errors in the Mach meter of the airplane you are flying. In many aircraft the Mach meter reads low near Mach 1. You're actually supersonic a little before you get the jump on the meter.

The Air Force continues to study this new phenomenon of aviation and further tests are being conducted to determine with greater certainty just what restrictions must be placed on current aircraft and also on those of the future.

• •

Convair has finished up on production on T-29s, but the line on military versions of the Convair-Liner keeps right on going with various models of the C-131 for the Air Force and R4Ys for the Navy. Convair delivered three C-131Bs in September, and 1956 deliveries to the Air Force will include six C-131Ds, three TC-131Es, six RC-131Fs and one RC-131G. Convair has a backlog of 33 R4Ys.

• •

Wonder who picks the names for guided missiles? Douglas, for example, has a couple of new ones on the way. One is called the Bird Dog. Another is termed the Ding-Dong.

Bird Dog we can understand, but we confess to being in doubt on the precise significance of Ding-Dong. Unless the idea is to imply it "rings a bell."

• •

Ned Root, director of public relations for Convair, recently was hauled off to the hospital for an operation. "Serious?" asked a well-wisher. "Medically, no," cracked Dick Gottschall, an aide. "Financially, yes."

# Hughes Reveals Details of Fire Control Systems

By FRED S. HUNTER

How Hughes Aircraft Co. developed the first automatic fire control system and then skyrocketed into one of the nation's top 10 manufacturers in defense contracts was revealed when Howard Hughes recently broke seven years of silence and gave newsmen a glimpse of his big main plants at Culver City, Calif. and Tucson, Ariz.

In 1948, the Air Force went to American industry seeking a company to develop an electronic system which would enable all-weather jet interceptor pilots to locate and shoot down attacking high-speed bombers without seeing them.

Hughes Aircraft—then a division of Hughes Tool Co.—had a small electronic department of less than 100 persons, whose most notable accomplishment up to then had been the development of a terrain clearance indicator for airliners. Hughes' interest in this device stemmed from his majority holdings in TWA.

• **From a simple** terrain clearance indicator to a complex fire control system was a giant step, but the Hughes company entered a bid. Moreover, it was the only company which said it could develop and build a flight model of the system in a year. Others said it would take at least twice that time. Hughes got the contract.

Then, five months after the contract was signed, with the international situation becoming more tense, the Air Force came to Hughes to ask: "Can you give us flight test in four months, production six months later?"

This was when Howard Hughes began pouring his millions into the facility which now embraces the nation's largest organization of industrial scientists working exclusively on electronics for the military and has become so vital a cog in our defense.

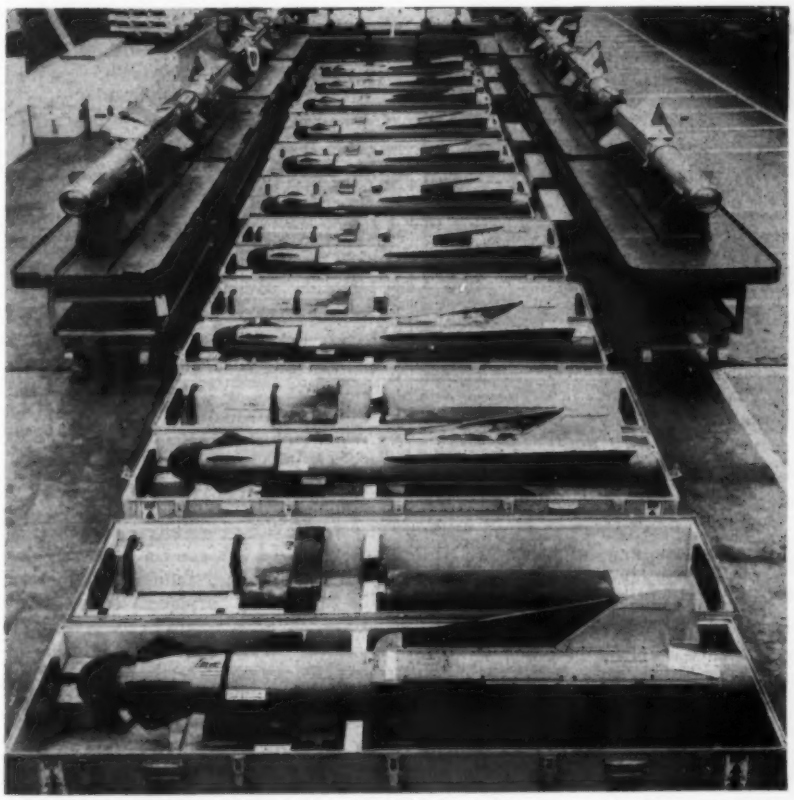
Hughes has never said how much money he has put into the Hughes Aircraft Co., but some idea may be gleaned from the fact that a few years ago when Lockheed Aircraft Corp. tried to buy it the negotiating figure was generally understood to have been in the area of $60,000,000.

• **Call it what you will,** the sheer weight of the Hughes millions—which he was willing to spend—or the genius of Howard Hughes for getting things done, the fact remains the flight test schedule was met. The production schedule was beaten—by two days. A few months later came the official report from Eglin Field, Florida:

An Air Force interceptor pilot using the Hughes fire control system had, for the first time in history, located and shot down a drone bomber without seeing it.

Thus, in an atmosphere of tension and 60-hour engineering weeks, Hughes produced the first E-1. It wasn't the perfect fire control system, but it worked. And it put Hughes so far out in front in this field no competitor has been able to catch up.

• **Hughes Aircraft** has now turned out more than 8,000 "seek-find-and-kill" systems and the gun-firing E-1



READY FOR SHIPMENT. Closeup view shows Falcon missiles awaiting Air Force acceptance at Hughes Tucson plant. Falcon's shell is magnesium.

FINAL CHECKOUT of Falcons in this shock and vibration test cradle simulates in-flight environment missile will be exposed to in jet fighter operation.

# 500° F AMBIENT SOLENOID

Ideal for high speed aircraft and missiles

**This solenoid is designed to operate over a temperature range of –67° F to as high as a scorching 600° F, and over a voltage range of 14 to 30 volts d-c. Has a continuous life of 500 hours at 500° F, longer at lower ambients.**

**Special impregnation makes it unusually compact. Eliminated is the bulky insulation between turns common to other high-temperature units of this type. This impregnation also makes the coil impervious to salt spray and fungus. Design data includes:**

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| Stroke | .156 inches |
| Coil Resistance | 14.5 ohms @ –67° F<br>21 ohms @ +70° F<br>33 ohms @ +500° F |
| Force | 1 pound minimum |
| Weight | 0.7 pound |
| Operating Voltage | 14 to 30 d-c |

**Other J&H high-temperature solenoids** include a d-c unit having an .080-inch stroke and 3-pound force . . . an a-c unit with a .100-inch stroke and 3-pound force. Others can be created to answer your specific requirements. Write Jack & Heintz, Inc., 17633 Broadway, Cleveland 1, Ohio. Export Dept., 13 E. 40th St., New York 16, N. Y.

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Rotomotive AIRCRAFT EQUIPMENT

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has been succeeded by new numbers, like E-4, E-5 and E-6 to designate the rocket-launching systems for the Air Force's current group of interceptors, North American's F86-D, Lockheed's F-94C and Northrop's F-89D.

There are later E numbers on the classified list and new designations for more advanced systems being developed under Air Force contracts. The latter will fire either rockets or guided missiles, including the Hughes GAR-1 Falcon, which is in production at Tucson. These systems are programmed for Convair's new supersonic, delta wing F-102 and Northrop's F-89H, among others.

One of the new Hughes systems coming up will automatically control a plane from the moment it leaves the runway until it returns to base after a mission. Whether this may become available for Convair's forthcoming F-102B has not been disclosed.

• **Meanwhile, Hughes** continues improvements in his E systems. One late advancement is the development of a device called CSTI, for "Control Surface Tie-In," to make the attack run of North American's F-86D completely automatic. After radar is locked on the target, the CSTI receives steering signals from the fire control system's computer and through actuators automatically moves the airplanes' control surfaces.

The Falcon-guided missile—in effect an extension of the Hughes electronic control system for interceptors—has proved sufficiently effective for the Air Force for Hughes to outline a multi-million dollar expansion program for the missiles production plant at Tucson.

"The Air Force is increasing the application of Falcon guided missiles to more and more types of planes," explained L. A. Hyland, vice president and general manager of the Hughes company.

• **Once more Hughes** is spending his own money in extending the facility at Tucson, although this plant is government-owned. Hughes built it originally at a cost of about $8,000,000, but later transferred title to the government. The production tooling, valued at about $6,000,000, is government-owned, as is about $15,000,000 worth of test equipment designed and built by Hughes for checking out Falcons to tactical performance requirements.

There are reports that new models of the supersonic GAR-1 Falcon are being designed for use on day fighters—like North American's F-100 and Lockheed's F-104—as well as the new all-weather interceptors such as the Convair F-102. But no confirmation could be obtained either from Hughes or the Air Force.

• **On the other hand,** Nathan I. Hall, vice president and director of the weapons systems laboratory, dropped hints of an improved Falcon being near.

Tabbing the GAR-1 as "the Model T of guided missiles," Hall indicated Hughes is working on new missiles quite different in principle and function from the Falcon.

"Only a small percentage of our engineers are now working on the Falcon," said Hall. "The rest are working on the development of the new Cadillac of guided missiles."

The scientist also noted that in addition to developing additional guided missiles, Hughes is at work on electronic countermeasures to defend against just such weapons as the Falcon and its successors.

• **Hall pointed out** that while the U.S. spent nearly $1,000,000,000 on missiles in fiscal 1955, the amount was about one-tenth that spent on military aircraft. He predicted that in the next 10 to 15 years, missile expenditures will equal or surpass those for military aircraft.

In outlining the GAR-1's advantages for interception fire power, Hall emphasized its capability of climbing thousands of feet to find its target.

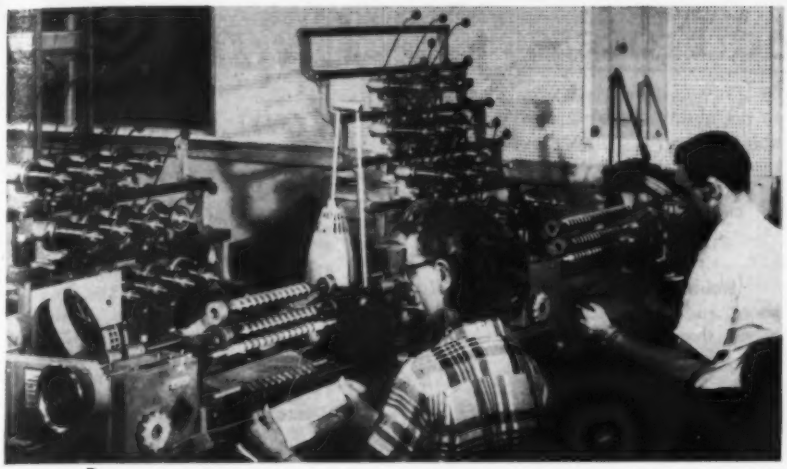
With guns or rocket armament, an interceptor has to fly at the target altitude to attack, he pointed out. An interceptor armed with Falcons—which, incidentally, can be fired singly or in salvo—need not climb so high. This saves design compromise on aircraft performance and also affords pilots the safety of more moderate altitudes.

• **Stepped-up Falcon production** may make Hughes Arizona's largest employer, with an annual payroll estimated at more than $25,000,000. Employment presently at 4,371 is to be increased to a target of 5,500 by the end of 1956, "and we will very probably grow beyond that," said W. W. Wooldridge, vice president and manager of Tucson operations.

Hughes is in process of transferring all missile program product engineering functions from Culver City to Tucson. New engineers are being hired rather than transferring from California.

Wooldridge also disclosed that Hughes has just brought 15 other manufacturing companies throughout the country into the Falcon guided missile production program. These companies are expected to be in full production on their work assignments by the third quarter of 1956. Wooldridge said subcontracting will represent more than 50% of the total production effort as a result of the Tucson expansion.

Hughes is supplying Falcons in one container ready for tactical use by the Air Force. This called for construction



AUTOMATIC PRODUCTION techniques speed Falcon output. Automatic multiple coil winding machines shown here each wind 12 copper wire coils at one time for electro-magnets in Falcon's control system.

of what is called the "Final Assembly and Checkout Facility"—a 500-foot long, 60-foot wide building—where the solid-propellant rocket motor, warhead, fuse and booster are assembled into the electro-mechanisms of the Falcon.

Eight large igloos built in the desert at a safe distance both from the main plant and the final assembly building are used to store the rocket motors, warheads and fuses. After assembly of the inert explosive units, the complete missile is packed in a single container in two major parts.

• **As of October 1,** Hughes employment totalled 19,317 persons. Of these, 10,946 were at the main plant in Culver City, 4,000 in leased structures at the Los Angeles International Airport site, and 4,371 at Tucson. The company's total annual payroll is $81,422,000. Its annual sales in 1954 exceeded $200,000,000 and its current backlog is in excess of $316,000,000.

Research and development personnel, including those employed in laboratories, machine shops, drafting rooms and supporting administrative departments, total approximately 5,500. Of these about 2,000 are scientists or engineers and one in 10 is a Ph.D. One in four holds a master's degree.

Engineering turnover, according to weapons laboratory chief Hall, is the lowest since establishment of the company. Engineers, said Hall, like the working environment at Hughes, particularly the research and development policy of establishing numerous individual labs, where small groups engage in their specialties in private, instead of the usual large groupings generally seen in engineering departments.

The research and development program generally is divided into two sections: weapons system development laboratories and research laboratories. The latter group deals primarily with microwave and electron tube work while weapon systems involves development of electronic control systems and guided missiles.

• **Another example** of Hughes growth is represented by its field service department. Hughes field service points around the world now total 160. Personnel numbers about 1,800.

The Hughes Aircraft Co. is wholly owned by the Howard Hughes Medical Institute, a nonprofit institute for medical research, and is now wholly separated from the Hughes Tool Co. The tool company retains an aircraft division—which, incidentally, is a subcontractor of Hughes Aircraft and fabricates such things as nose sections for Hughes fire control systems—with R. E. Hopper, formerly chief engineer of Hughes Aircraft, as vice president and manager.

Transfer of the Hughes Aircraft assets to the medical institute took place only a little over a year ago and no report of profits has yet been made, although there are indications one may be forthcoming shortly. ◆◆◆

## Permanency Cases Nearing Completion

At press-time, two local service airlines—Southwest and Trans-Texas—had been issued permanent certificates, 10 others were engaged in show-cause proceedings aimed at immediate permanency, and a show-cause order for Mohawk Airlines was expected shortly.

Thus the expedited procedure set up by CAB to carry out permanency legislation for the local industry was well on its way to completion.

Southwest and TTA were exceptions to the general rule because the issue of permanency was simply added to their renewal cases.


NEW TYPE OVERVOLTAGE RELAY

Unaffected by environment... needs no rectifier

**Easy adjustment** to desired voltage limits, long life, reliability and simplicity are other features incorporated in this J&H overvoltage relay for aircraft. While designed primarily for J&H a-c control panels, it works equally well on any a-c system or control panel.

**This "glow switch"** relay offers the following improvements over present overvoltage relay circuitry:

- Calibrations unaffected by mounting position, altitude, or acceleration in any direction.
- Hermetic sealing prevents damage from humidity, fungus, dust and salt spray.
- A-c power is sensed direct; relay needs no rectifiers.
- Low stand-by power drain.
- Adjustable minimum trip voltage and time delay.
- Smaller and lighter over-all circuit.

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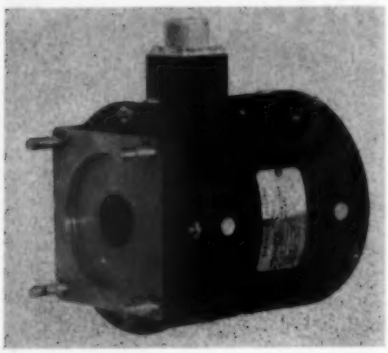
# New Products and Processes

### 400-CYCLE ALTERNATOR



**General Electric's** Specialty Component Motor Department has announced a new 400-cycle, 12,000-rpm alternator for application on guided missiles and aircraft.

The alternator can be driven by a wide variety of prime movers, including d-c motors, jet air drives and turbines, using either solid or liquid propellants. It is designed to meet extreme environmental requirements for periods of short duration, weighs less than 15 lbs. A further weight reduction can be effected by substituting an AND 10261-type mounting pad for the normal AND 20001 pad.

**Circle No. 165 on Reader Service Card.**

### VERTICAL GYROSCOPE SYSTEM

A compensated vertical gyroscope system said to provide for unlimited freedom in roll and high angular freedom in pitch has been announced by **Gyromechanisms, Inc.** It is designated Model 40,000.

According to the manufacturer, an accuracy of one-quarter of a degree from true vertical can be realized over a pre-set range of speed during straight flight and also during and after turns.

**Circle No. 166 on Reader Service Card.**

### BRACKET, SHOCK MOUNTINGS

Engineers of the Stillman Rubber Co. and the Lockheed Aircraft Corp. have jointly developed a new type of aluminum and rubber support bracket and shock mountings.

Trade-named Flexmount, the mountings have been used to support after-body engine sections of the Lockheed 1049 Super Constellation. The Flexmount was designed to withstand applied loads in shear and additional loads caused by engine vibrations.

Loads are taken out by 11¼-in. diameter bolts, with the vibration completely absorbed by a Neoprene rubber core 1 1/16 x 1⅛ x 1¼ ins., bonded to the aluminum. Adaptations are available or can be designed for most other piston-powered aircraft. The rubber can be replaced when worn.

**Circle No. 164 on Reader Service Card.**

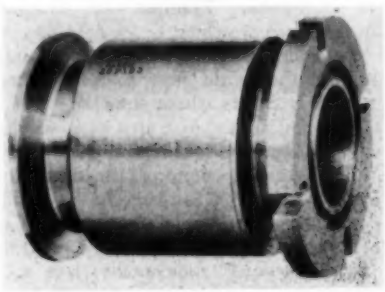
### TUBE SHOCK MOUNT

**Robinson Aviation, Inc.** is making shock and vibration mounts for electron tubes that use Met-L-Flex spring-enclosed cushions to attenuate shock and vibration between the tube sleeve and its outer support. Miniaturized mounting is available in Model K271.

The manufacturer says performance is unimpaired by temperatures from —130°F to 375°F. Flexible electrical leads can be securely connected at the base of the tube without hampering the mount's resilient action.

**Circle No. 157 on Reader Service Card.**

### FLOW VALVES

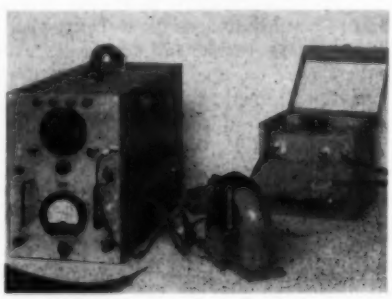


**Allen Aircraft Products, Inc.** has announced a new line of two-way flow valves for aircraft oils, fuels, air or fuel vapors.

According to the manufacturer, these valves have a much smaller envelope than conventional offset-flow two-way valves. Concentric flow pattern is said to give excellent flow-pressure characteristics with minimum spread between cracking and reseat pressures. Shown here is the 1¼ in. size. Other sizes are available.

**Circle No. 167 on Reader Service Card.**

### MAGNETRON TESTER



A portable magnetron field test instrument that weighs 35 lbs. is now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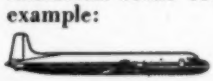
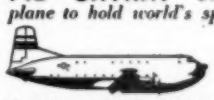
At DOUGLAS you'll be associated with top engineers who have designed the key airplanes and missiles on the American scene today. For example:



**DC-7 "SEVEN SEAS"** *America's finest, fastest airliner*

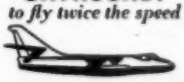
**F4D "SKYRAY"** *Only carrier plane to hold world's speed record*



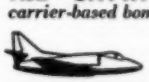
**C-124 "GLOBEMASTER"** *World's largest production transport*

**NIKE** *Supersonic missile selected to protect our cities*

**"SKYROCKET"** *First airplane to fly twice the speed of sound*



**A3D "SKYWARRIOR"** *Largest carrier-based bomber*



**A4D "SKYHAWK"** *Smallest, lightest atom bomb carrier*

**B-66** *Speedy, versatile jet bomber*

With its airplanes bracketing the field from the largest personnel and cargo transports to the smallest combat types, and a broad variety of missiles, Douglas offers the engineer and scientist unequalled job security, and the greatest opportunity for advancement.

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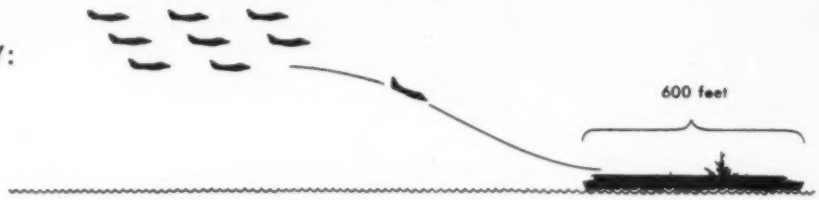
TACTICAL PROBLEM: ***To design and build a jet bomber able to operate from the smallest World War II "jeep" carriers.***

PRACTICAL REPLY:

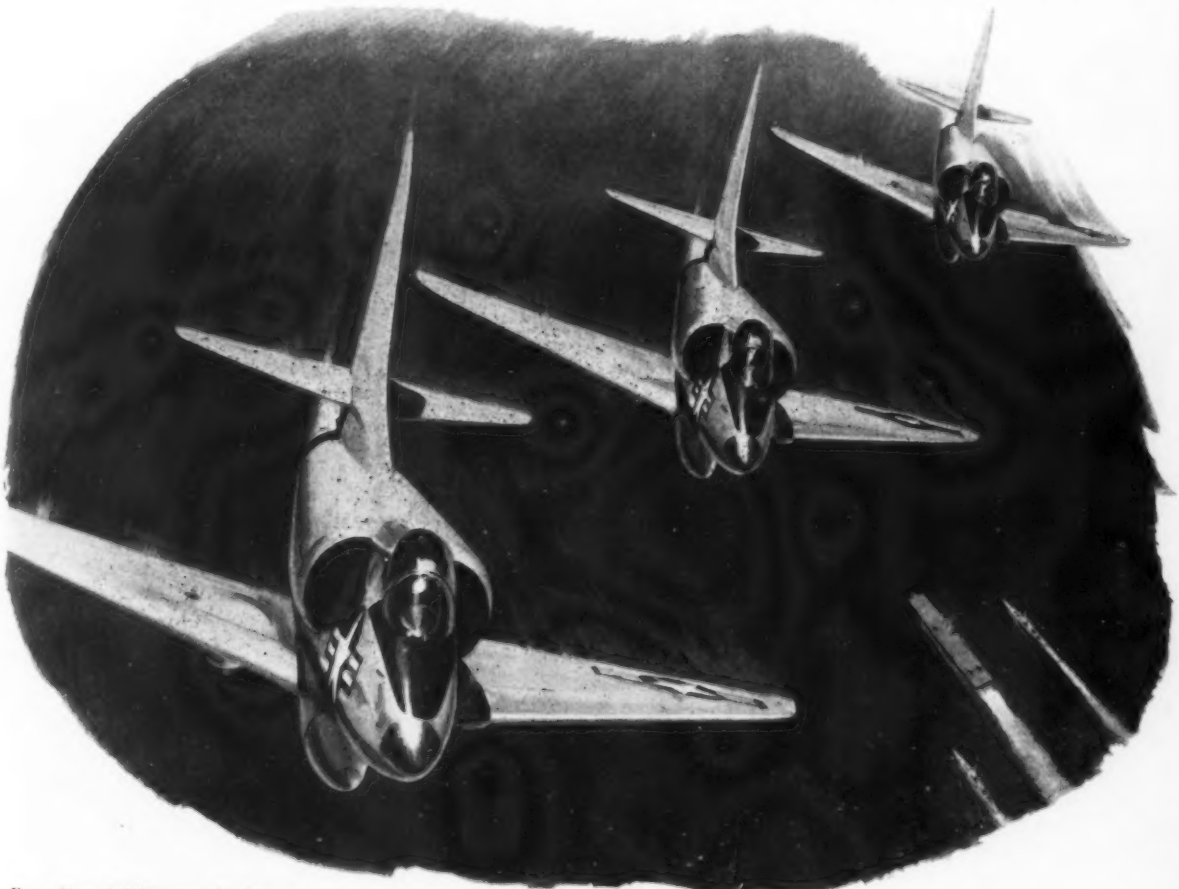



# The DOUGLAS A4D Skyhawk

Designed for the U. S. Navy and now in volume production, the Douglas A4D Skyhawk cuts many of the tactical restrictions imposed by the higher landing and take-off speeds of modern jet aircraft.

This compact attack bomber flies faster and farther with a greater striking load than any airplane of comparable size . . . outspeeds many jet fighters twice its size. Yet it can fly with ease from "jeep" carriers and short, advanced airstrips barred to most jets. Wingspan is so short that Skyhawk can be stored in quantity aboard carriers *without folding its wings*—a simplification that makes important savings in both weight and fuel.

Performance of A4D Skyhawk is another example of Douglas leadership in aviation. Greater utility with lower production cost, through highly simplified design, is always a rule at Douglas.



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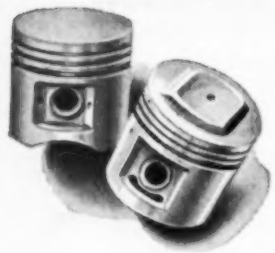
NEW USES FOR STRAITS TIN



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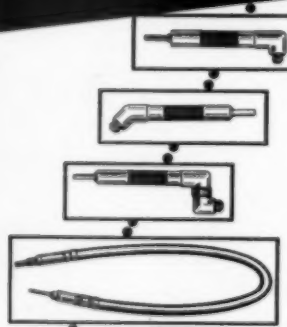

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## NEW PRODUCTS

available from **U. S. Electronics Corp. of America.** The manufacturer says it is adequate for field evaluation of a large number of magnetron types in present use and manufacture. Magnetrons under test are supplied with filament potential through a pulse transformer. The filament-cathode is pulsed through a delay network. A spark gap serves as switching means.

Modulation voltage is indicated as a vertical deflection on a cathode ray tube. A scale for reading pulse peak modulating voltages up to 30KV. is provided. The filament voltmeter has ranges of 0-10 volts and 0-25 volts. Operating frequency of the "S" band is 1 percent, and "X" band 0.3 percent.

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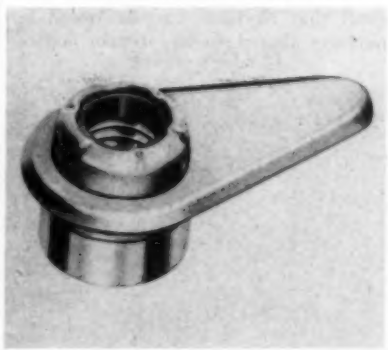
### SELF-WRENCHING LOCKNUT



A new steel self-wrenching locknut developed by the **Elastic Stop Nut Corp. of America** is said to have greater resistance to fatigue and less weight than most locknuts.

The locknut shown has a lug that braces itself against an adjoining surface to prevent rotation of the nut during the wrenching of a bolt.

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### SEQUENCE VALVES

A new line of sequence valves of the slide-type, for 3,000 psi hydraulic service, has been announced by **Aircraft Products Co.**

Designed Series 4,000, these valves are said to feature extremely low leakage and low pressure drop. Stock models have a standard maximum internal leakage of 15 drops per minute. Special models are available with maximum leakage values as low as five drops per minute.

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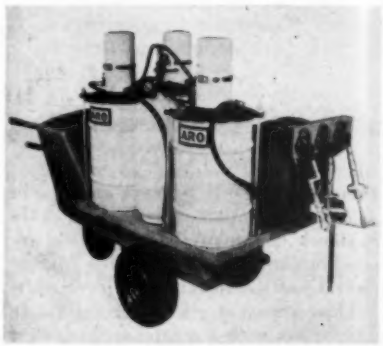
### SELF-POWERED LUBRICATOR



A self-propelled, self-powered portable lubricating unit, believed to be the only one of its type on the market, has been announced by the **Aero Equipment Corp.**

The Aro Prime Lubricator provides power lubrication at airports and also has many industrial applications. It is powered by a 6-hp air-cooled engine and has a maximum speed of slightly less than 4 mi. per hr., suited to normal walking speed. A single-stage air compressor provides ample air pressure to handle all requirements of the lubricating system.

Three hose-reels, each with 25 feet of hose, enable the operator to reach out-of-the-way fittings easily.

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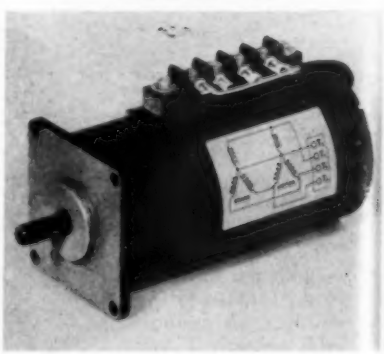
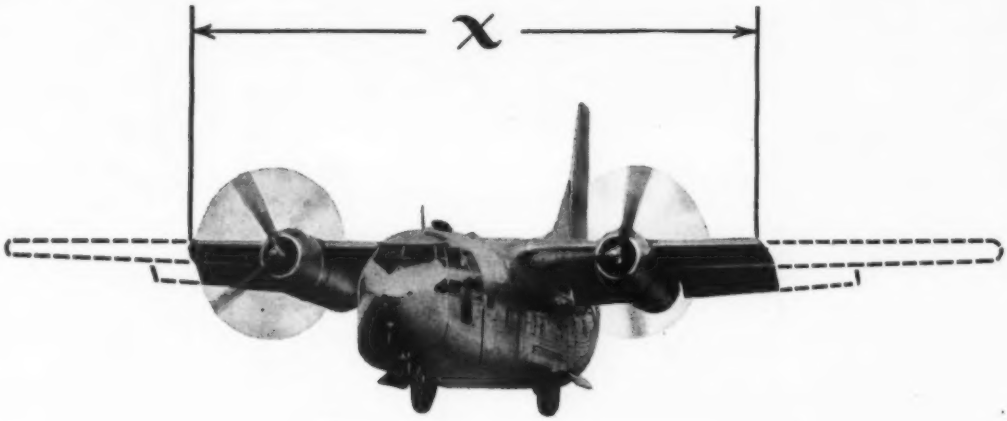
### BRAKE MOTOR

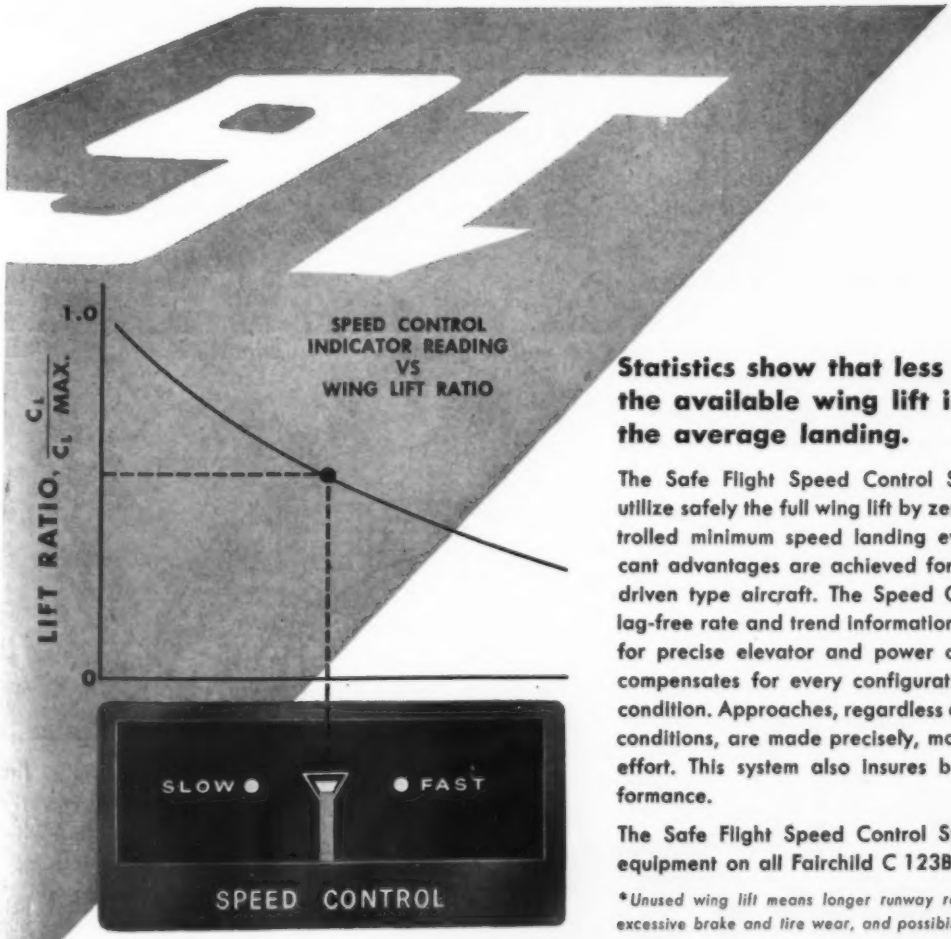


**Air Associates, Inc.** has developed a new three-phase, 400-cycle ac brake motor for Douglas Aircraft Co.'s supersonic F4D Skyray, to drive the "elevon" pitch trim system on the bat-winged Navy interceptor.

Designated M-8201-M2, the unit is

# How much* of the available WING LIFT are YOU using?

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The Safe Flight Speed Control System is now standard equipment on all Fairchild C 123B aircraft.

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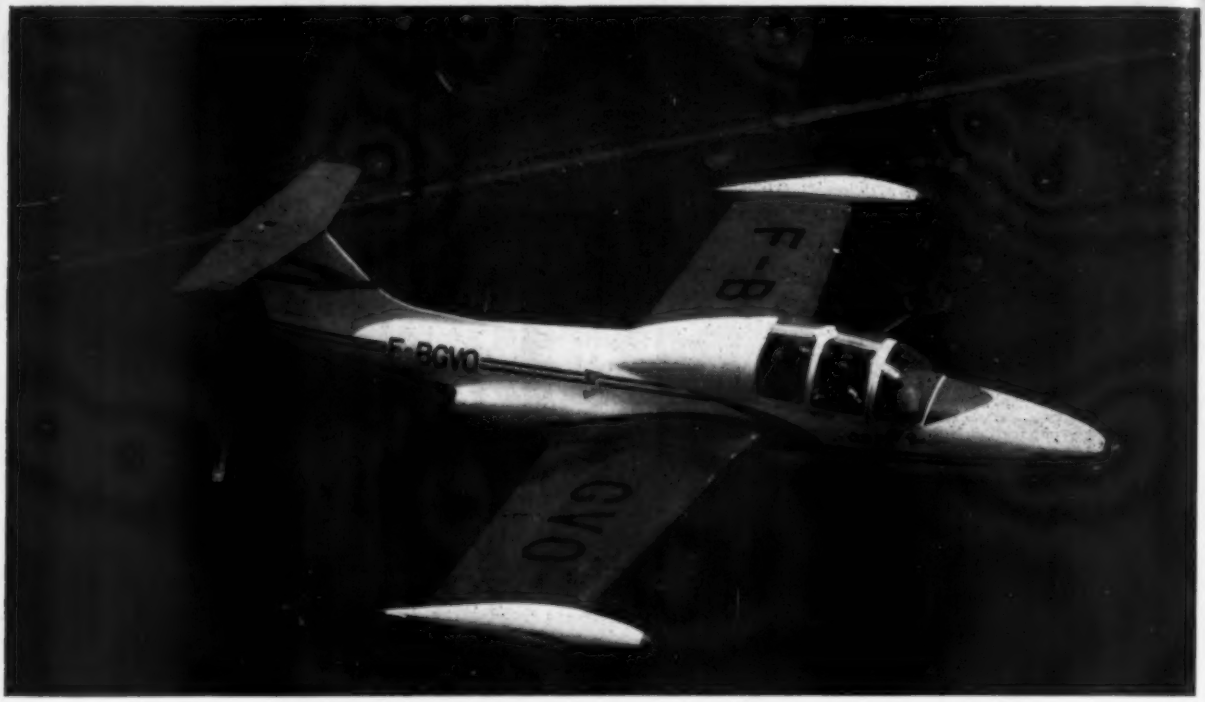



# Salute to the Paris

Early in June 1955 the twin-jet, four-place executive airplane PARIS, built by Morane-Saulnier of France with the type designation MS 760, started a demonstration tour of the United States and Canada under the sponsorship of the Beech Aircraft Corporation.

In ninety days it carried a total of 1820 people, not including the pilots. It made 724 demonstration flights from a total of 38 different airports.

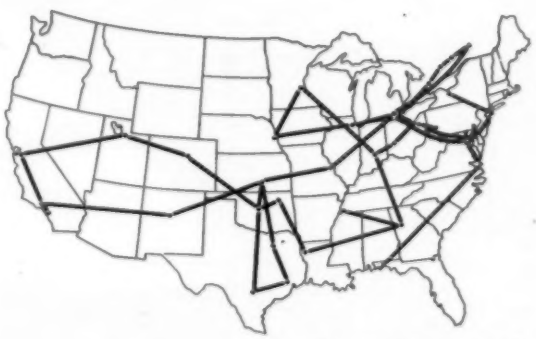
It never required a revision of schedule or cancellation of a flight, in spite of an itinerary that was planned sixty days in advance.

Its record of maintenance shows that less than 0.85 man-hours of maintenance time was required per hour of flight time for this 410 miles-per-hour airplane.

It never required a battery cart for starting the two jet engines, or even an overnight battery charge.

The reaction of skilled jet pilots to both its flight and landing characteristics has been uniformly one of enthusiasm and pleasure. One top-level jet expert expressed it briefly, "Goshalmighty, *what* a Doll!"

BEECHCRAFT salutes the Morane-Saulnier designers and constructors for an outstanding achievement and a milestone in aeronautical progress – the MS 760 "PARIS".

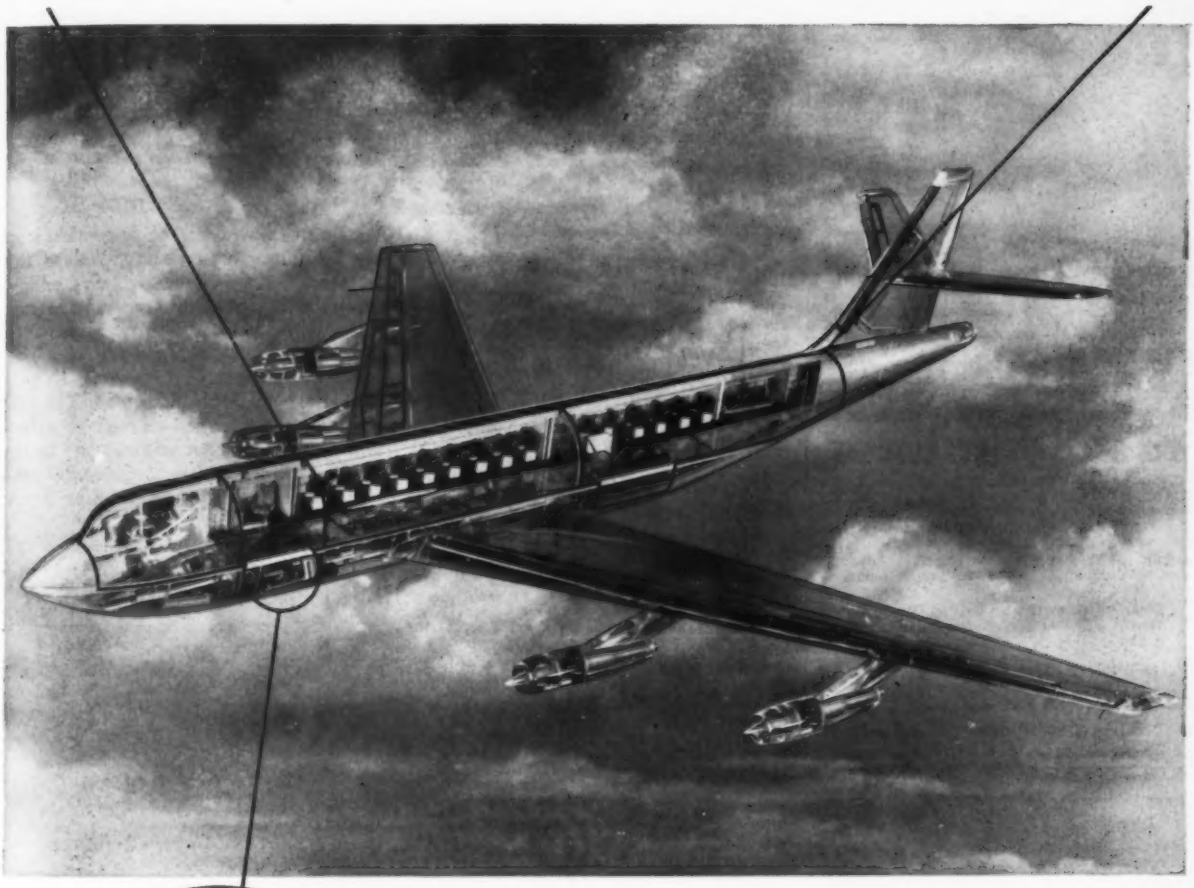


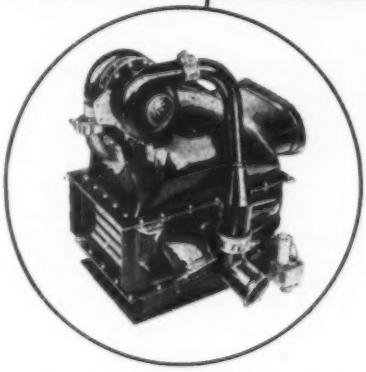
**This is the route of the "Paris" on Beechcraft's ninety-day nation-wide demonstration tour.**

*Beech Aircraft Corporation*
*Wichita, Kansas, U. S. A.*

***BEECHCRAFTS ARE THE AIR FLEET OF AMERICAN BUSINESS***

# Cabin air conditioning





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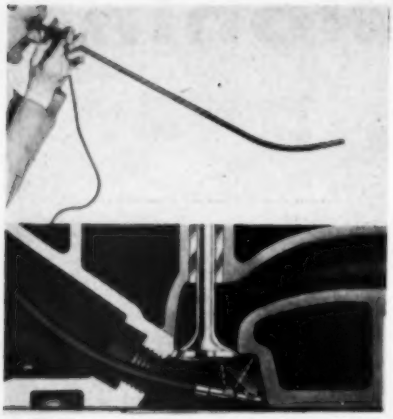

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## NEW PRODUCTS

a 1/12 hp reversible motor operating at 11,000 rpm on the 115/120-volt system. A specially designed brake produces a holding torque of 2 in.-lbs. Normal operation is said to be unaffected by failure of one of the three power lines.

The motor measures 2 in. in diameter, 3.94 in. in length and weighs 1.5 lbs.

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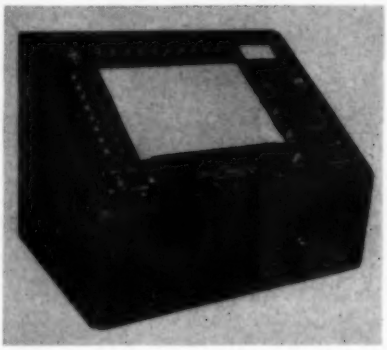
### CIRCUIT TESTER



**DIT-MCO Inc.,** manufacturer of automatic circuit analyzers, has announced a new Model 80 that can test as many as 80 circuits automatically. A cable connection adapts it to any panel assembly or cabling system for testing connections, resistance and insulation of many resistance type devices such as relays, solenoids, panel lights, etc.

The manufacturer says continuity is closely defined to the point of rejecting ½-ohm continuity resistance, or as an open circuit at current up to 2 amperes. Leakage resistance is said to be closely defined to the point of rejecting 0 to 200 ohms as a direct short.

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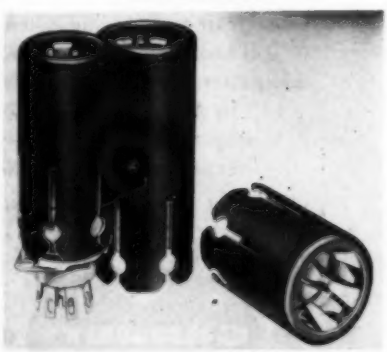
### TUBE SHIELDS



A new **International Electronics Research Corp.** tube shield provides cooling of electron tubes for longest tube life and reliability. Designed for direct replacement of JAN shields for Jan-7 and 9-pin miniature sockets, the manufacturer says the TR series shields reduce bare bulb temperature by 20 to 25% and on high wattage "hot" tubes 15%. A 50% reduction in bulb temperature achieved by standard JAN shields is said to be effected. The shield was developed at the request of a major airline as a protection against premature tube failures.

Circle No. 163 on Reader Service Card.

### SILICON DIODES

Eight new types of bonded silicon crystal diodes have been added to the **Raytheon Mfg. Co.** line of sealed silicon diodes. With peak inverse voltage ratings from 3.0 to 225 volts, a complete line of twelve types are available. The new types are: 1N432, 1N460, 1N433, 1N434, 1N437, 1N438, 1N439. The latter four are designed as voltage references or regulators at voltages of 3 to 11.

Raytheon says the diodes offer stability and low reverse current from —55C to +150C.

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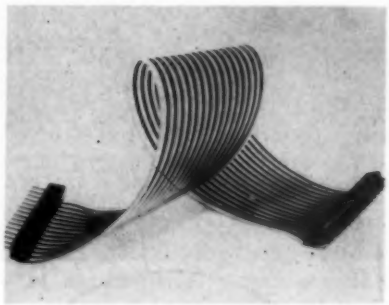
### PRINTED CIRCUIT CABLE



A circuit cable of laminated Kel-F plastic and copper has been introduced by **Sanders Associates, Inc.** The conductors, made of thin copper sheets, are completely encapsulated in the plastic.

Additional conducting and insulating layers can be added to the basic cable to provide a greater number of separate conductors. Three layers are possible, depending upon flexibility required. The manufacturer says up to five-layer construction has been built.

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### GEAR BOXES

**Southwestern Industries** offers a new series of flexible gear boxes with a wide range of gear ratios, from 4:1 to 12,000-1, providing torque from 150 in.-oz. to 200 in.-oz.

The gear boxes are designed so they can be mounted directly to small electric motors. They are available in two series, 145 and 167. Series 145 provides up to 150 in.-oz. of torque; series 167, up to 200 in.-oz. Weight ranges from 2½ to 5 oz.

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## TWA'S NEW SUPER G CONSTELLATION

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### TO KEEP ITS MUSCLES IN SHAPE

Every time this "Super G" Constellation lifts a flap, lowers a wheel or uses any of the dozens of functions of the hydraulic power system —a pair of PR-412-8 Purolator Micronic* filters goes to work, too. Like all Purolator filters designed especially for aircraft use, these are lightweight units (only 43 ounces). Yet they are Military approved for 3000 psi service. They protect vital valves, cylinders and pumps from entrained products of wear, metal chips and dust that could cause serious blockage or abrasion.

These installations on TWA's "Super G" are another example of Purolator's 25 years of leadership in aircraft filtration. Purolator filters for hydraulic systems, fuel, lube oil and instrument air have proved themselves on hundreds of thousands of planes—military and commercial. And each year, as more advanced equipment has posed more and more stringent requirements, specially designed Purolators have been built to meet the need. If you're interested in these developments and haven't seen our latest catalog on aircraft filters, write for a copy today. Address Dept. A2-102, Purolator Products, Inc., Rahway, N. J.

*Reg. U. S. Pat Off.

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## INDUSTRY NEWS

# PAA Orders Both Boeing and Douglas Jets

- **Rash of orders from other major U.S. airlines expected as result of Pan Am's $269-million decision.**
- **First delivery of 707s scheduled for December, 1958; DC-8s to start arriving year later.**

By WILLIAM V. HENZEY

PAN American World Airways "broke the ice" this month with a $269-million order for 45 American-built jet transport aircraft, all of which are scheduled for delivery within the next five years.

As tension mounted among airlines in the race to be the first U.S.-jet purchaser and between manufacturers to be the first U.S.-jet seller, Pan Am solved both races by ordering 25 Douglas-built DC-8s and 20 Boeing 707s.

The order was expected to touch off a rash of orders from other major U.S. lines such as United, American, Eastern and possibly TWA. Because of its split nature, it was also seen as assuring virtual success for both manufacturers in the commercial jet field, since Pan Am alone has given each about one-third of the business said to be needed for break-even projects.

• **First deliveries** by Boeing will start in December, 1958, ending in November, 1959. In December, 1959, Douglas will start delivering DC-8s to Pan Am, with the order scheduled for completion in January, 1961.

The Boeing 707s will be powered by four Pratt & Whitney J57 engines, cost a total of $109 million, including spares, and will carry 104 first-class passengers and 125 in tourist configuration.

The DC-8s will use more powerful P&W J75 engines, cost a total of $160 million including spares, and will carry 108 first-class or 131 tourist passengers.

Both planes, according to Pan Am, are designed to cruise at 575 miles an hour at 30,000 feet. By way of emphasizing these facts, Boeing flew its prototype 707 on Oct. 16 from Seattle to New York in record time of 3 hrs., 58 minutes.

• **Pan Am intends** to place the new jets in transatlantic, South American, and transpacific services in the five-month period beginning December, 1958.

Sample times on proposed new schedules are: New York-Paris, 6 hrs., 35 minutes; New York-Buenos Aires, 11 hrs., 15 minutes, and Tokyo-Seattle 8 hrs., 32 minutes.

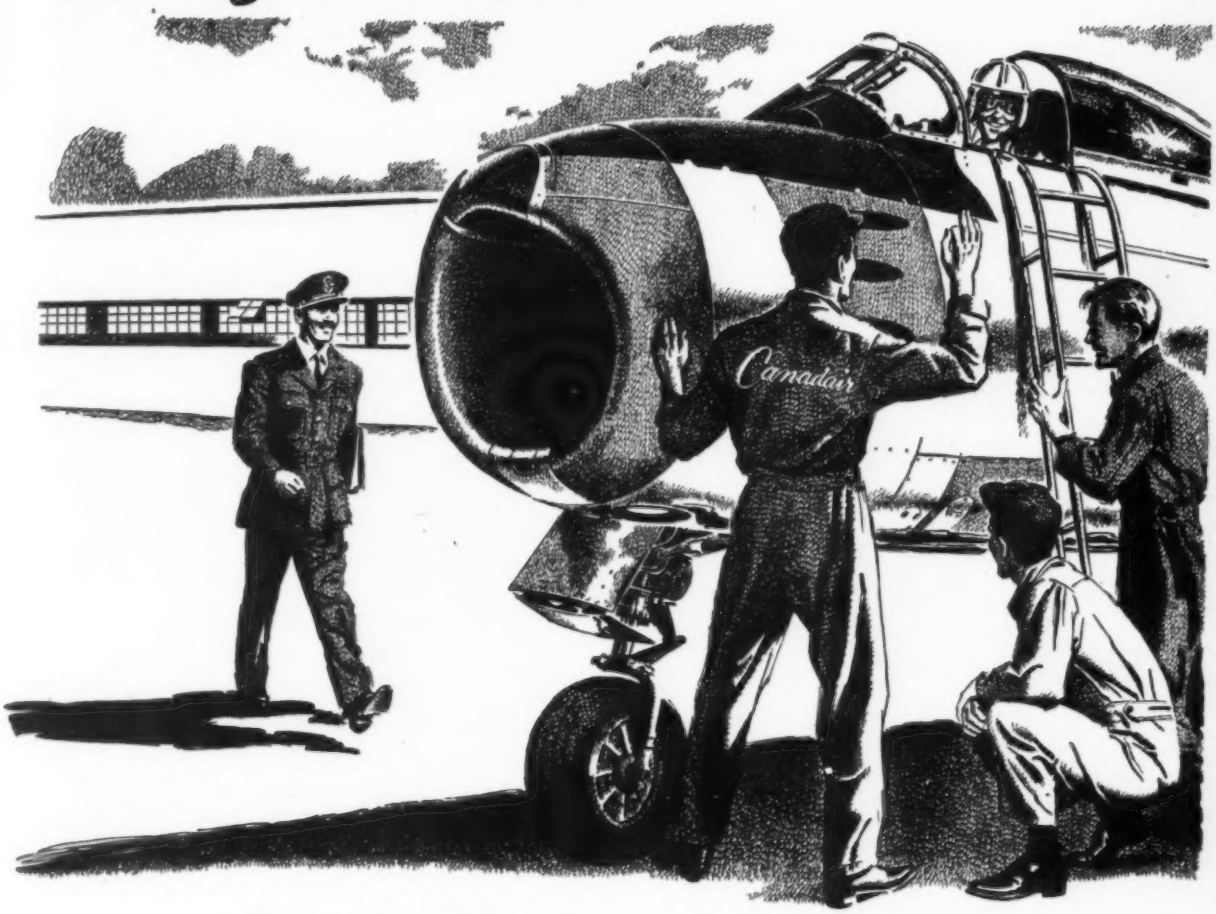
Donald W. Douglas, president of Douglas Aircraft, hailed his firm's deal with Pan Am as "the largest and most significant single contract in the history of commercial aviation . . . opening a new chapter in global aviation and bringing the jet age closer to the lives of millions throughout the world."

The Boeing-Pan Am contract "marks the beginning of a new era in air transportation," according to Boeing president William M. Allen, who added: "Introduction of the 707 Jet Stratoliner on Pan American's routes will, in effect, make the world 40% smaller."

• **Pan Am's president,** Juan T. Trippe said the new order plus PAA orders outstanding, which add up to a total aircraft commitment of $357 million, is "concrete evidence of Pan American's faith and confidence in the continued expansion of sound two-way international trade as well as greatly increased tourist travel between the U.S. and the 74 friendly foreign nations

Artist's sketch of Boeing 707 in Pan American dress.

# We bridge the Oceans...

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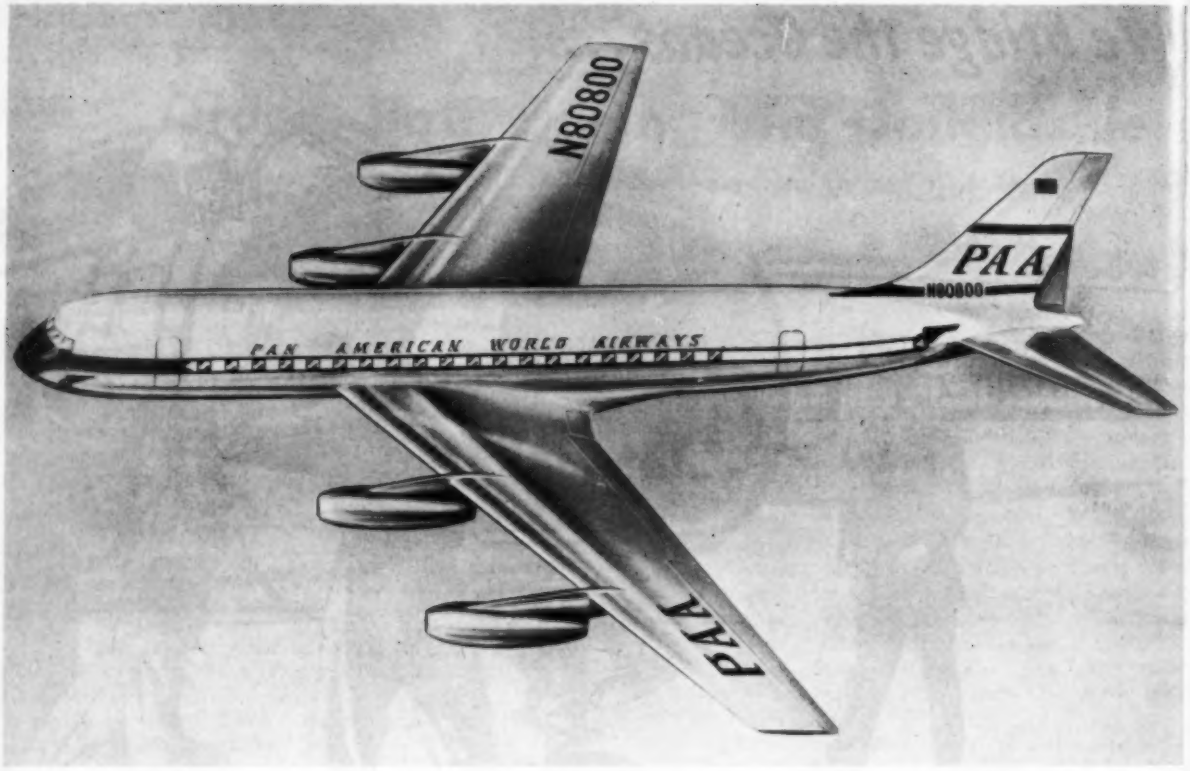


Douglas DC-8 as it will look with Pan American markings.

which are regularly serviced by Pan American."

Vice President Richard Nixon, Secretary of Commerce Sinclair Weeks, Air Force Secretary Donald A. Quarles, and CAB Chairman Ross Rizley were among important Federal officials who hailed the -Pan Am announcement as a tremendous lift to Aviation and a significant contribution to the national economy.

But while Pan Am, backed by a Douglas statement that the DC-8 purchase is the "first firm agreement for U.S.-built jet transports," appeared first in line, many other U.S. carriers gave evidence that little time advantage would be surrendered to competitors in the jet race.

• **Foremost in point of time,** if not in size of order, was National Airlines, which still insists it has the first commitment for the Douglas DC-8. Last August, testifying under oath at CAB hearings in the New York-Florida Case, NAL president G. T. Baker said his company has placed orders for six DC-8s costing about $36 million.

Further, Baker said National has "firm delivery dates" for four DC-8s in 1959 and two in 1960. Whether Pan Am or National was first appeared to hinge on whether you wished to judge between a written contract, such as Pan Am entered with Douglas, or an oral contract, which Baker says National entered with the DC-8 manufacturer.

United Air Lines was scheduled to make its recommendations to its directors on October 25. The Airlines' officials held final conferences with Boeing and Douglas in mid-October. UAL president W. A. Patterson, J. A. Herlihy, v.p.-engineering and maintenance, and W. C. Mentzer, chief engineer, headed the UAL team in the final talks.

• **Eastern's board chairman,** E. V. Rickenbacker recently said his company has allocated $125 million for 20 jet transports but had not yet made its mind up as between the DC-8 and the 707. A decision is expected at any time.

American, normally a heavy Douglas purchaser and a proud possessor of many "firsts" when it comes to new aircraft types, has not yet made its mind up and only last week had a team of engineering experts actively studying the 707 in Seattle.

Both American and Eastern, of course, previously announced so-called "gap-bridging" orders for turboprop Lockheed Electras.

• **Trans World Airlines,** a big question mark, is rumored interested in the 707 but such rumor must be considered as the purest speculation at this time.

Latest carrier to evidence jet interest was Continental Air Lines, whose president, Robert Six, was at Douglas in mid-October checking details with the DC-8 project group. Continental's interest in a jet transport is said to center around its equipment interchange operations.

Actually, none but the smallest U.S. lines can be eliminated from the race which, in terms of domestic orders alone, gives promise of a $1 billion pot to be divided between the two manufacturers. And this does not take into consideration inevitable orders from foreign airlines.

What effect increased orders have on pricing of the new jets remains to be seen. Early reports indicate the basic price of the Boeing 707 of $4.3 million will be adjusted downward to $4.1 million if 65 airplanes are sold.

• **Price on the DC-8** powered with P&W J75 engines reportedly is just over the $5 million figure, or about $400,000 more than the basic price of the J57-powered DC-8.

The substantial cost of these planes, when related to past prices for piston-engined aircraft, is largely responsible for the cat-and-mouse game being played by various airlines.

Particularly adroit has been UAL's Patterson, who has alternately hinted at UAL leanings toward the DC-8 and the 707, and even suggested that U.S.

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companies may pool their orders with a unit price gain as a major advantage.

• **Some indication** of the amounts now required to stay in the competitive airline race can be obtained from the recent Pan Am order and that announced earlier by Eastern. Pan Am's total of $357 million for new equipment and Eastern's for $350 are each about equivalent to the total assets of the domestic trunkline industry ten years ago.

In fact, the combined net assets of the nine regional trunks and 13 local service airlines in 1954 was not as high as either of the two aircraft orders.

With such enormous amounts involved in each airline's order, therefore, even a 5% reduction in unit price, such as reportedly is contemplated by Boeing for quantity production, means substantial savings to the purchasers.

For example, the purchaser of 20 707s would gain $4 million or virtually the price of one additional plane if the 65-plane goal is exceeded. The same would hold true for Douglas purchasers, of course, if that firm is thinking along the same lines.

• **But while extreme optimism** has invaded the U.S. manufacturing picture, the potential U.S.-airline market for British de Havilland Comet jetliners appeared to be waning.

Pan Am's Boeing and Douglas orders appeared to wipe out PAA's previous order for three Comets. PAA's only comment was that it continues to be interested in de Havilland jet transports and there are "certain confidential understandings" between the two companies looking toward a "fruitful outcome."

There is, however, general industry belief that PAA's contract with de Havilland contained a clause nullifying the order if U.S.-built jets should be available for delivery at the same time.

Thus has the jet age in this country passed the talking stage. ◈◈◈

# British Make New Bid For Turboprop Market

- **Canadair, Bristol and Convair may join forces in production of Bristol Super-Britannia.**
- **British European Airways negotiating for fleet of Viscount 900s.**

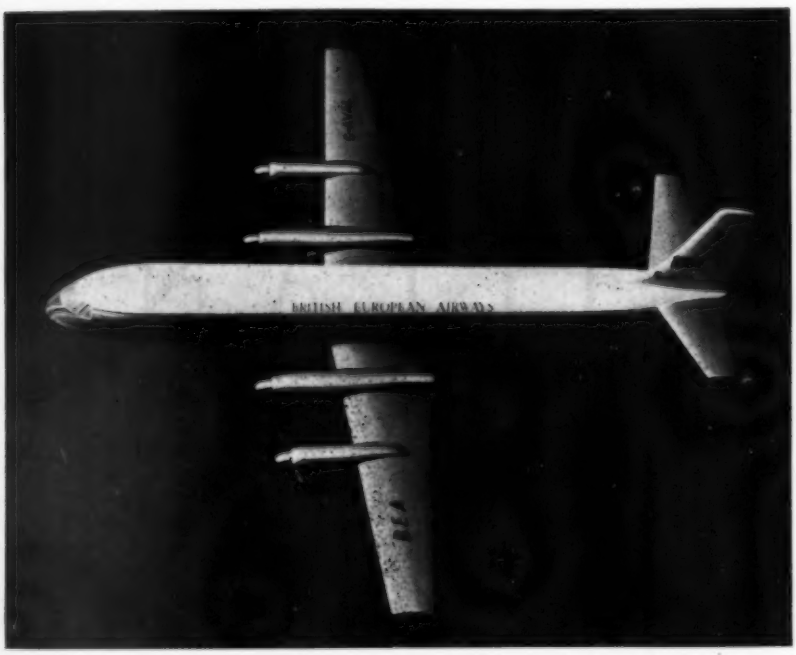
The role of British aircraft and engine producers as key contenders in the future turboprop transport market was further shaped last week in two major developments.

• **Canadair, Ltd.** disclosed first details of a projected three-nation tie-up under which it would join with Britain's Bristol Aeroplane Co. and Convair in the U.S. in the design and production of the Bristol Super Britannia turboprop.

• **British European Airways** announced it is negotiating with Vickers-Armstrongs Ltd. for a fleet (believed to be 30) of new Viscount 900 Vanguard turboprops for 1960 delivery.

Together, the new projects put British-designed turboprops powered by British engines in two open slots in the future transport picture.

The tri-nation Super Britannia project, if it materializes, will offer a 500-mph turboprop in the long-range, high-capacity category to fill the gap between the Lockheed Electra turboprop and Boeing/Douglas jets. On the other extreme, the new Vanguard provides a 425-mph turboprop for high-density operation at ranges up to 2,500 miles.




Latest entry in turboprop transport field is new Vickers 900.

### Deal Not Yet Final

• **Although** the Canadair-Convair-Bristol deal is not yet finalized, Canadair officials conformed that it is currently "under intense study." But the project target, calling for 1960 delivery of the Super Britannia, virtually dictates that final decisions will have to come soon if the aircraft is to develop as a major entry in current airline re-equipment programs.

Best indications are that the plan would call for final assembly of the aircraft in the U.S. by Convair from components made partly at Convair and partly in Montreal by Canadair. In addition, other components would be imported from Bristol in England, as the new project does not affect that company's plans to build the Super Britannia in its Filton, England plant.

Use of Bristol's BE.25 "supercharged turboprop in the Super Britannia also makes probable the entry of a fourth major manufacturer, Curtiss-Wright Corp., in the project. Top officials of Convair and Bristol told AMERICAN AVIATION that both the engine and powerplant would have to be Americanized to give the Super Britannia its best chance of volume selling on the world market.

Current license agreements between Bristol and Curtiss-Wright are understood to give C-W "first refusal" on several Bristol engines, including the BE.25, thus making it the logical pro-

## This small plant helps build the world's mightiest bomber

Sounds impossible? It's a fact. This small, neat plant does a big and important job in protecting national security. It is Plasteck, Incorporated, which produces illuminated panels of luminated plastic for the Boeing B-52, mightiest of the world's global jet bombers. The Poteau, Oklahoma, factory employs 125 workers, making it a small business by definition of the Federal Government.

But this plant could as well be a tool-and-die works in Indiana . . . a small and highly specialized manufacturer of aircraft fasteners in Alabama . . . a fabricator of sheet metal parts in California. It could be any one of about 3,500 small businesses, each employing fewer than 500 workers, which are subcontractors and suppliers for the B-52. There are also nearly 1,000 larger firms supplying everything from rivets to complete subassemblies for this "long rifle" of the Air Force.

Many of the small suppliers and contractors for the B-52 also furnish parts and assemblies for other Boeing planes: the B-47 jet medium bomber, the KC-97 aerial tanker, and the forthcoming KC-135 jet tanker-transport. But there are many *additional* suppliers, too, for these planes. Again, roughly three-quarters of them are small businesses.

This network of suppliers—small and large—skilled in aircraft work, provides Boeing, and the nation, an unique flexibility in undertaking new projects, and for quick expansion in the event of a national emergency. In addition, other manufacturers supply equipment for the B-52 and other Boeing airplanes under separate Government contracts: engines, radio, radar, autopilot, armament, and so on. In many cases these manufacturers, too, have their own small-business subcontractors and suppliers throughout the land.

B-52s are now being delivered to Strategic Air Command. As one of the most powerful protectors of our country's security, it is fitting that the B-52 should be a nation-wide project. Small, medium and large businesses in 35 of our 48 states help produce it.

BOEING

ducer of engines for the "Americanized" Britannia.

### Viscount 900 Details

• **Future production** of another of Britain's newer turboprop engine designs, the Rolls-Royce RB-109, becomes a certainty with BEA's fleet order for the Viscount 900 Vanguard.

Powered by four RB-109s, the Vanguard is slanted for high payload-short range operation on heavy traffic routes and will carry from 93 passengers in a five-abreast, seating up to 105 passengers maximum.

BEA specification for the Vanguard calls for a payload of 21,000 pounds for distances of 500 miles with full reserves. Cruising speed initially will be 400 mph based on a limited 4,000 horsepower from early RB-109 engines, but this will be increased to 425 mph when full engine power output is later used.

Gross weight of the Vanguard was not disclosed. However, it is believed to be in the vicinity of 110,000 pounds, a figure generally associated with a new short-range transport known to be under development at Vickers for some time.

• **Basic Vanguard layout,** which is being designed to meet a 50-page BEA set of requirements drawn up this year, will handle mixed first-class and tourist service in addition to its role as a high-density tourist transport.

In the BEA arrangement passengers will be accommodated in three compartments, a forward area seating 20 persons, central seating 50 and a rear area seating 23. Conversion to a combined first-class tourist interior would be handled by a movable bulkhead which would divide the central compartment.

Forward of this bulkhead, and in the forward area, a total of 45 tourist passengers could be accommodated. Forty first-class seats could then be arranged in the rear portion of the central compartment and in the rear seating area, giving the "mixed" version of the Vanguard maximum seating of 85 passengers.

Other cabin features of the new turboprop include:

• **Wider cabin**—passenger compartment width is 9 ft., 11 in.—15 inches wider than the Viscount 700.

• **Stair Doors**—Two main entrances will be provided, one fore and aft on the left side. Both will be fitted with folding "air-stairs."

• **Panorama Windows**—The Vanguard will have 19 Viscount-type panorama windows on each side of the fuselage. ◆ ◆ ◆

# CAA Proposes $500-Million Airways Program

**• Five-year plan calls for integration of military radar, civil radar and secondary systems.**

By LOIS C. PHILMUS

CIVIL Aeronautics Administration has completed a draft of an accelerated five-year program for airways development and operation. The program has been submitted to Secretary of Commerce Sinclair Weeks for approval. It is understood that CAA's plans for establishment of airways facilities and their operation and maintenance would require appropriations close to 500 million dollars for the fiscal years 1957-1961.

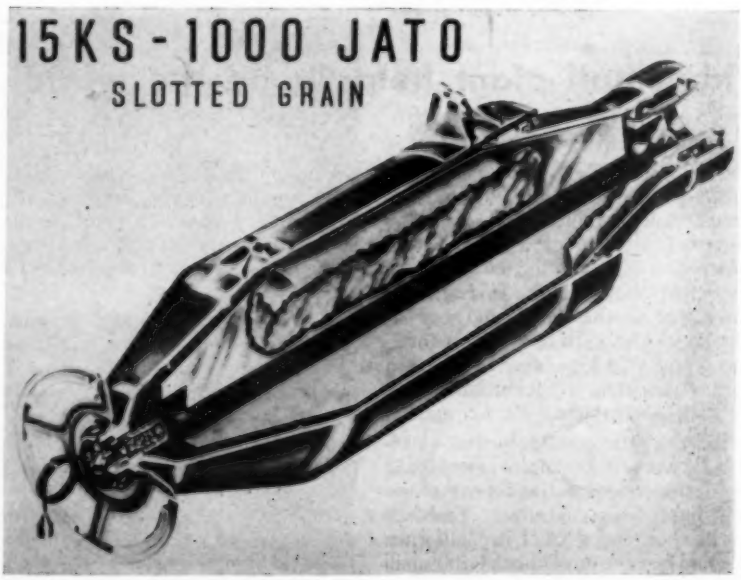
Drafting of the program was undertaken because of Congressional directive. At the close of the last session, Congress instructed CAA to return in January with a definite program attached to its appropriation request.

In its report to the House, the Appropriations Committee stated: "The committee . . . directs that no stations or facilities now operating be discontinued by the Civil Aeronautics Administration, and that there be reported to the Appropriate Committees of the Senate and House of Representatives a comprehensive plan for future air traffic control routes, facilities, and stations, which shall in any event be made available to this committee and to the Appropriations Committee of the House of Representatives prior to the submission of the budget for fiscal year 1957."

AMERICAN AVIATION first learned of the CAA plan following some of the strongest criticism ever leveled at CAA for "dragging its feet" on airways and air traffic control development. Critics included Lt. Gen. Joseph Smith, MATS Commander, in a keynote speech before the Radio Technical Commission for Aeronautics at its fall assembly banquet in September.

Chief deterrent to acceptance of the complete CAA plan by Department of Commerce probably is the large expenditure involved.

**First CAA-Approved Aircraft Rocket Engine**




Aerojet-General Corp's 15KS-1000 aircraft rocket engine has been certificated by the CAA with a rating of 1,000 pounds thrust for 15 seconds. The 15KS-1000 was originally developed for Navy Bureau of Aeronautics. In civil service, it will be used as standby power on commercial and executive transports.

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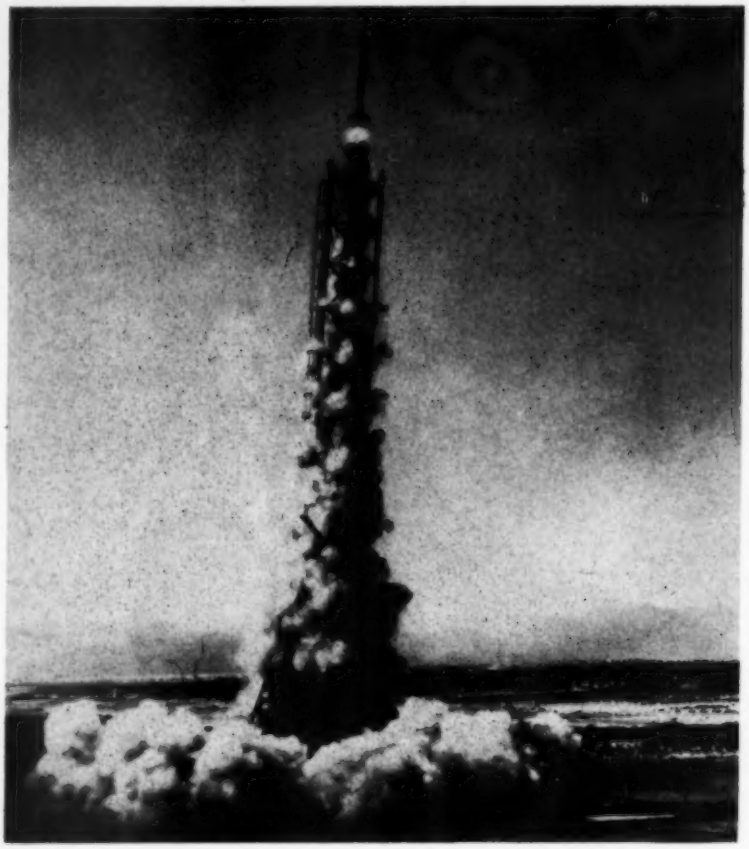
# NORTHWEST *Orient* AIRLINES

## Probing the Atmosphere—100 Miles Up



While the Aerojet-General Aerobee shown here on a research sounding mission is scheduled to reach altitudes of 180 miles, it already has played a major role in probing the outer atmosphere. On a recent mission, an Aerobee equipped with aerial cameras photographed a million and a quarter square miles of the world from an altitude of 100 miles. Included in the panoramic view was the first photograph of an entire hurricane 1,000 miles in diameter.

CAA's plan heavily emphasizes widespread use of radar.

In considering the maximum use of radar, the possibility of joint military civil use of military radar installations already in existence has been reportedly under extensive study. CAA Administrator Fred B. Lee, in a recent speech in Dallas before the National Association of State Aviation Officials, referring to the "ready-made network of military radar," said: "By using some of this military radar and filling the chinks with additional civil radar, we believe we can meet our needs of the next five or ten years without imposing a too heavy burden on the taxpayer."

"To use existing military radar," he revealed, "it will be necessary to remote the scopes to our traffic control centers in most cases. We are investigating the use of closed-circuit television, coaxial cable and UHF radio in the remoting. In some instances, it may be cheaper to move the controllers for one sector to the radar, rather than moving the radar to the controllers. Each situation is being studied to find the most efficient and economical solution."

The remoting would involve considerable expenditure, but would help provide all Air Route Traffic Control Centers within the next five years, a major objective of the five year plan. A total of 70 more long-range radar systems would be needed, most of which can be provided through joint use.

Critical military requirements for high altitude control are expected to receive first attention in the early stages of the plan. Because of the continuing common system objectives, military use of the airspace has influenced the CAA program.

Various studies by CAA have ascertained that even if TACAN is eventually adopted for the common system, it would be at least eight to 10 years before the system could be completely operational. The five-year plan, therefore, asks for continuation of VOR/DME and increased installations of DME in conjunction with ILS.

Budget requirements for the plan would be: $27 million in fiscal 1957; $63,409,000 in fiscal 1958; $62,451,000 in fiscal 1959; $52,310,000 in fiscal 1960, and $40,576,000 in fiscal 1961. If approved, it would provide the agency with about $245 million to establish facilities. Maintenance and operation of the system will require about $158,875,000 by fiscal 1961, rising from $108,619,000 in fiscal 1957 as the program gets under way.

Plan calls for the following:

• **Airport Surveillance Radar**—An additional 44 locations would be added to the 43 programmed as of June 30, 1955 and two for fiscal 1956. First step toward this goal will be contained in the fiscal 1957 budget request.

• **Long-Range Radar**—CAA and the military are working out the most practical plan for integrating civil use of defense radar and a study will determine the extent of future joint use. Each ADC radar will be studied individually. Fiscal 1957 plans call for long-range radar at four locations and replacement of obsolete equipment at one control center.

• **Secondary Radar System**—Evaluation of the radar beacon system, begun late in 1954, is expected to be completed by January 1957, with experimental installations in the New York area, later in Washington and Chicago, dependent on the success of the first test facility.

Plans call for installing ATC interrogators (secondary radar) to supplement all ASR and long-range radar. With this in mind, CAA has programmed a total of 134 through 1961. Fiscal 1957 calls for putting ground interrogators in with 27 ASR's and at eight longer range radar sites. Installation of 53 airborne transponders is contemplated for CAA aircraft, along with procurement of an additional 11 for training and spares.

• **VOR/DME**—CAA has based its program on the assumption that the present system will continue as part of the over-all common system, noting, however, that TACAN's integration is indefinite. In its planning, CAA has estimated that 383 additional VOR/DME facilities will be required to supplement the 498 expected to be operational by the end of 1956. CAA will ask Congress for 16 new VORs. If TACAN is ever adopted, the installation of 814 units through 1961 would be required.

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• **Airport Traffic Control Service**—Forty additional places probably will require control service by the end of the five-year period, CAA estimates, adding to the 174 locations in operation at the end of the last fiscal year. Congress will be asked to provide financing in fiscal 1957 for establishment of tower service at eight locations, seven of which will be with existing INSACs to form combined communication and tower center. Also, next year probably will see the establishment of separate INSACs and towers at four presently combined stations.

• **Air Route Traffic Control Centers**—All 31 (26 in continental U. S.) will be equipped radar-wise if plans are adopted. To get the ball rolling, CAA has set up a fiscal 1957 program calling for: long-range radar at four locations; an item for providing UHF air-ground communication channels for centers; and items for relocation of four air-route control centers to permit expansion and modernization; establishment of teletype functions; expansion of 12 centers by adding additional control sectors; and extension of center radio communications by setting up peripheral communication channels.

• **ILS/DME**—An additional 28 ILS's are envisioned over the next five years to add up to the 165 programmed this year, of which 152 are commissioned, five unassigned and eight under way. CAA would like to have DME combined at all stations, with 170 programmed for 1956 and 28 more in the planning stage. Funds may be asked in fiscal 1958.

A new development, now under test, may eventually replace glide slope antennas at several locations to improve system. Automatically controlled approaches down to lower minimums are predicted by future development of airborne equipment. Fiscal 1957 funds will be used for improvement of present installations, with no additional units programmed.

• **Approach Lighting System**—With six systems in operation at the close of fiscal 1955, CAA estimates the need for 57 systems for standardization and to implement additional locations expected to qualify under criteria through 1961.

• **Lead-In Lighting System**—Noting that the standardized centerline system will supplant the outmoded left-hand row neon systems on visual approaches, the need for runway lights extending into the approach zone is stressed. Based on the forecast of instrument approaches for the next five years, an additional 106 lead-in systems have been planned to supplement the 71 neon left-hand row systems now in operation and the one incandescent, centerline system.

• **Sequenced Flashing Lights**—About 34 of the airports qualifying for the fixed light approach system will also be equipped with sequenced flashing lights.

• **L/MF radio ranges would** be completely abandoned because of the near completion of the VHF omniranges, but the large number of military aircraft without VOR receivers precludes the step at this time. CAA hopes to be able to discontinue the ranges by fiscal 1959, retaining about 88 for broadcast and limited navigational purposes.

• **INSACS**—A limited need for additional stations is forecast for the future, with only minor relocations for wider coverage anticipated.

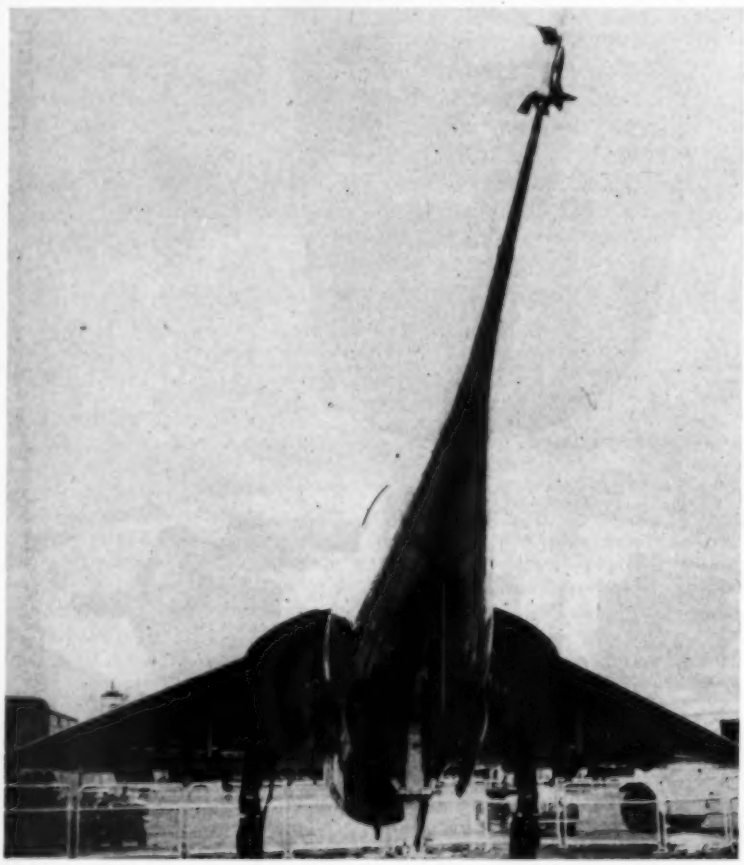
Also included in the comprehensive five-year establishment and operations program, is a plan for the associated components of the system, as follows:

• **Airport Surface Detection Equipment**—Specially designed radar has been undergoing extensive evaluation tests. If equipment proves out, the military is expected to take delivery on units this fiscal year and CAA can begin its operational evaluation in fiscal 1957, with orders placed the following year. Twenty installations are planned at large heavy traffic airports in metropolitan areas.

• **Air Traffic Control Coordinating Equipment**—The Indianapolis Technical Development and Evaluation Center is currently developing and evaluating various types of equipment. CAA has estimated that operational equipment will not be available until fiscal 1960 and has programmed for distribution to control centers and towers accordingly.

• **Direct Center/Pilot Communications**—Ultimately, each control position in each traffic control center will be equipped with a discreet radio com-

## 'Droop Snoot' with Nose in the Air



This unusual photo of the Fairey Delta 2 single-seat delta-wing research plane was taken at the SBAC display at Farnborough. Plane is powered by a Rolls-Royce Avon and is the second British aircraft capable of supersonic speed in level flight. Nose can be lowered to give pilot better view during takeoff and landing, thus the nickname "Droop-Snoot."

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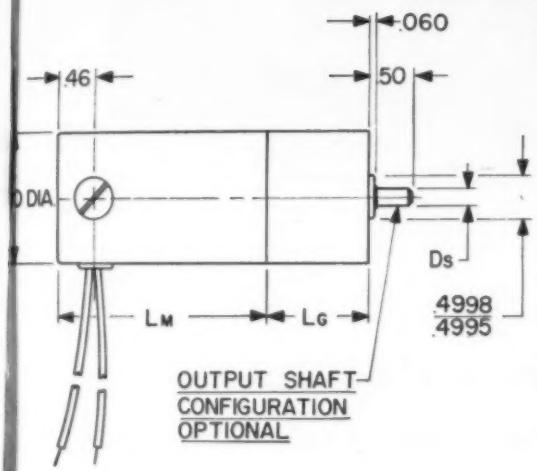


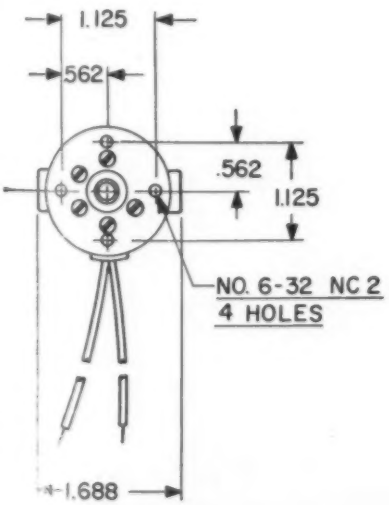


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|---|---|---|---|---|---|
| | LM=2-15/16" | LM=2-13/16" | LM=2-9/16" | LM=2-13/32" | LM=2-9/64" |
| 368 | 21.3 | 19.1 | 14.2 | 11.0 | 8.9 |
| 320 | 24.7 | 21.8 | 16.0 | 12.6 | 9.9 |
| 240 | 34.9 | 31.1 | 24.7 | 19.1 | 14.2 |
| 160 | 55.8 | 49.5 | 34.9 | 27.8 | 20.1 |
| 80 | 104 | 93.0 | 73.4 | 57.2 | 49.5 |
| 40 | 255 | 224 | 160 | 112.3 | 99 |
| 20 | 510 | 456 | 364 | 288 | 224 |
| 16 | 655 | 579 | 408 | 363 | 288 |
| 8.0 | 1315 | 1160 | 922 | 737 | 579 |
| 3.50 | 3290 | 2630 | 2345 | 1880 | 1490 |
| 3.1 | | 3290 | 2345 | 1675 | 1315 |
| 2.5 | | | 3290 | 2630 | 2105 |
| 2 | | | | 3290 | 2345 |
| 1.6 | | | | | 3290 |

GEAR TRAIN LENGTH

| SHAFT SPEED—RPM | .94 TO 19 | 19 TO 456 | 510 TO 1032 | 1165 TO 3290 |
|---|---|---|---|---|
| GEAR TRAIN LENGTH—LG. | 1-15/16 IN. | 1-3/16 IN. | 7/8 IN. | 3/4 IN. |
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munication outlet for direct air/ground communication with pilots. Most urgent need is in the northeastern portion of the country.

• **Long Distance Navigation**—The military has requested CAA to install Consolan (American development similar to British Consol system) at several locations, to be completed in the spring of 1956 at Nantucket, Mass. and Atlantic City, N. J. on the east coast; near Pescadero, Calif., and Lompoc, Calif., in the west. Military funds are being used. Seven additional installations may be made in the U.S. and possessions in the next five years. Consolan installations have been designed for possible conversion to NAVARHO, if the latter becomes standard.

• **Direction-Finding Equipment**—Although engineering difficulties have delayed deliveries, a few of the 62 sets ordered may be delivered next August. Plans call for installing the VHF/UHF DFE at all long range and airport surveillance radar locations, integrating the military and CAA DF network in the U.S. with control centers serving as net control stations.

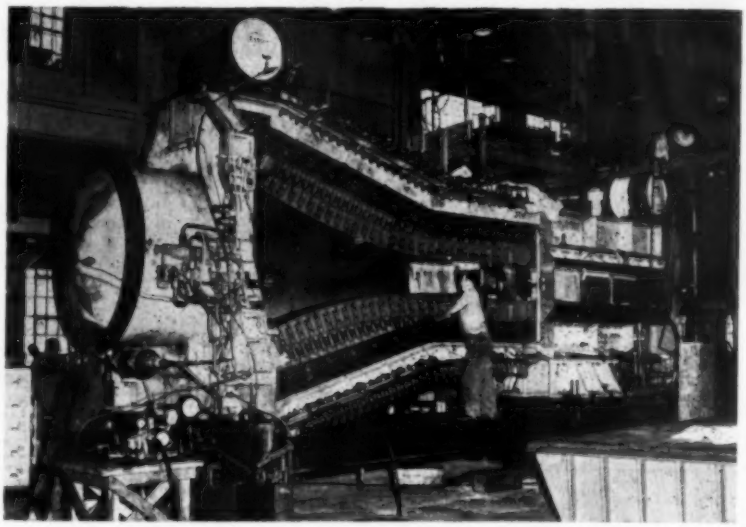
• **Non-Directional Radio Beacons**—CAA would install no new radio beacons and would discontinue the system as quickly as possible. The system would already have been discontinued, it is noted, but for the failure of the airlines to equip with DME and the military with VOR/DME. Only pressing traffic control problems will compel CAA to install additional equipment.

• **Precision Approach Radar**—Although eight PAR's were installed by July and an additional 14 programmed, CAA has found that the initial and recurring cost factor requires careful analysis of the benefits to be derived from the system versus its upkeep. Criteria for installation has been established at airports having 3,000 or more annual instrument approaches. Based on this, 20 more PAR's may be required over the next five years, although funds would not be immediately requested because of more important requirements.

• **Airway Light Beacons**—CAA wants to eliminate about half of the 848 beacons now in operation in fiscal 1957, eliminating the balance as soon thereafter as practicable.

• **Intermediate Landing Fields**—It is predicted that a study of general aviation will reveal that there is no economic justification for the continuance of intermediate fields in the U.S. and CAA will ask a 50% reduction in funds for operating the fields in the U.S. next year. Further reductions will be made as concurrence is obtained from military and other users.

## Throat of UAC's New Supersonic Windtunnel



This is United Aircraft Corp. research center's new supersonic windtunnel at East Hartford. Cross section view shows hydraulic jacks which control shape of center tube to alter airspeed and air flow within the tunnel. It has a test chamber, right, and special windows for observation and photography during tests. Tunnel was built by Electric Boat Division, General Dynamics Corp.

# CAB's New Service Mail Rates Draw Fire from Member Josh Lee

CAB has placed in effect a new multi-element service mail rate structure for the local service airline industry but the action drew criticism from Member Josh Lee, who argued the "new structure is good as far as it goes, but it doesn't go far enough."

Specifically, the structure, which is applicable from July 1, provides the same line-haul rate for locals as in effect for trunks—30.17¢ per ton-mile. In addition, varying terminal charges per pound of mail emplaned are added to provide total service mail pay.

The terminal charges increase as the size of the city decreases, so that the smallest city carries a terminal charge 10 times that for the largest cities.

• **CAB estimates** the new structure will result in a reduction in the local industry's annual service pay from $1,140,000 to $883,000.

Lee, however, says this is not adequate compensation for the small carriers who must provide the service although, many times, the mail volume is infinitesimal as, of course, is the resulting compensation.

As an example, he said, even though the small station's rate is 1,000 times that of a larger city, if only one pound of mail is put on the plane, the carrier receives only 33¢.

To further illustrate his contention, Lee called on the only experiment ever conducted by CAB with a "mail-only" operation, which occurred in the early '40s with All American Airways, predecessor company to Allegheny Airlines.

That experiment, Lee said, indicated the cost for providing mail service was 63.9¢ per revenue plane-mile. If that figure were applied to the estimated 44 million miles flown by the local industry in scheduled service, it would produce total service mail pay of over $28 million.

• **Lee emphasized** he wasn't advocating that much service pay for the locals, although it would be sufficient to wipe out the industry's subsidy. But he found the figure no more fantastic than the $883,000 now slated for the carriers which, when applied to the 44 million miles flown, produces about 2¢ per plane-mile compensation.

As an initial solution, Lee proposed that a $15 per day minimum station charge be included in the multi-element structure for locals particularly, but for all carriers to maintain uniformity of structure.

This would mean an increase in annual service pay for the local industry from $883,000 to $2,219,000. If it becomes necessary to offset an increase

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in trunklines' service pay, the Board Member suggested a reduction in the line-haul rate from 30.17¢ per ton-mile to 29¢.

Over-all effect of the line-haul rate change and the $15 minimum charge would be a $213,000 reduction in Big Four mail pay annually, a $754,000 increase in regional trunklines' mail pay, and a total service pay of $2,210,000 for the local industry. ◆ ◆ ◆

# Airline Dependence on Subsidies Drops, So CAB May Refund $4 Million

Instead of appealing to Congress next Spring for a supplemental subsidy appropriation, as was generally expected, the Civil Aeronautics Board may be in the unique position of refunding some of the taxpayers' money.

The potentially favorable development may come about if the declining dependence of the air industry on federal aid continues, as CAB earlier this month estimated it would.

For fiscal 1956, CAB figures the total subsidy needed for domestic, international and territorial air services will be $48.5 million, or some 33% less than was required in 1954. In dollars, that's a drop of $24 million.

• **Equally significant,** however, is the fact that the CAB amount is $4 million under the $52 million which Congress said CAB could have to meet airline subsidy needs for this fiscal year. The Congressional appropriation was considerably under a CAB request for $61.7 million, based on subsidy estimates of almost a year ago.

As was the case last year, it was generally expected that CAB would pay subsidies until they ran out, banking on a supplemental appropriation sometime next Spring. But the picture changed radically, and for the better, in the last few months.

Biggest improvement is in the international field where only last February CAB estimated over $29 million in subsidies would be needed. Now the trick will be accomplished with only $19.6 million.

• **Local service carriers** who originally were expected to need $25.1 million, will get by on $24 million. Also, whereas four domestic trunks were expected to need $4.5 million this year, the new CAB report shows that only two trunks will be subsidized at a total figure of $2,193,000.

Even the three U.S. helicopter lines won't need as much as originally anticipated, showing a drop of about $1 million to $2.8 million for the year.

Significant in this favorable picture are such things as the new non-subsidy status of transpacific operations where Pan American, Northwest, and United (to Hawaii) are self-sufficient, thanks chiefly to large doses of military mail which have upped service mail revenues to the point where subsidy is no longer required.

• **In the transatlantic field,** Trans World Airlines continues without subsidy and Pan American requires only $2.4 million.

Other non-subsidy international operations, although some of them have always been that way, are American to Mexico, National to Cuba, Eastern to Puerto Rico, Colonial to Bermuda, and Delta Air Lines throughout the Caribbean area.

Latin America is still the major subsidy area in the international field, although the $9.8 million now required is substantially less than the $16.1 million CAB thought would be needed.

• **Among the carriers,** Pan American's far-flung system is the most heavily subsidized but the $11.1 million needed this year is a far cry from the $24 million needed by PAA only two years ago. Ranking next are Trans-Texas and Frontier with $2.5 million each, Ozark with $2.4 million, and Piedmont with $2.1 million.

Service-wise, airmail volume is on the upgrade. While total service mail pay to the industry is increasing steadily, lower rates plus the sharp subsidy cut means the total of service pay and subsidy is declining in the face of more mail movements.

In 1951, 77,387,000 ton-miles of mail were moved in domestic and international service, with service pay and subsidy totalling $121,303,000. In the current fiscal year, volume will be almost double—145,694,000 ton-miles—but total service pay and subsidy will have dropped to $109,194,000.

• **Service pay** comes out of the Post Office budget and this year will be $60,475,000, compared with $55,630,000 for fiscal 1955.

Pan American will receive the most service pay, $13.6 million, with TWA next with $9.9 million, and United third with $8.2 million.

Significantly, because of lower rates, domestic trunklines, despite increased volume, will get less service pay this year — $31.3 million — than in 1954, when the total was $32.4 million.

# 26 Nations Agree To Sharp Increase in Airlines' Liability

An increase from $8,291 to $16,582 in the limit of liability of an air carrier for damages to passengers, baggage and cargo on international flights was agreed to at the recent diplomatic conference in The Hague on amendments to the Warsaw Convention. Twenty-six nations signed the protocol. Ratification by 30 is needed to make it effective.

The U.S. did not sign because President Eisenhower's illness prevented him from granting full powers to the delegation. However, the U.S. is expected to become a signatory as soon as possible. Ratification by the Senate is also necessary. The Iron Curtain countries attended the conference, and Russia, Poland and Czechoslovakia were among the signers.

An important change was also made in the article of the Convention which defines circumstances under which the $16,582 (250,000 Poincare

**Comparative Summary of Subsidy Estimates For Fiscal Years 1951 Through 1957**
**(In Thousands)**

| | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 |
|---|---|---|---|---|---|---|---|
| Domestic trunks | $18,881 | $ 6,411 | $ 3,527 | $ 3,880 | $ 3,059 | $ 2,193 | $ 2,187 |
| Local service | 17,310 | 18,990 | 21,800 | 24,570 | 23,040 | 24,088 | 24,608 |
| Helicopters | ..... | ..... | ..... | 2,574 | 2,657 | 2,814 | 2,803 |
| States-Alaskan operations | 792 | 2,075 | 3,226 | 3,391 | 3,517 | 3,343 | 3,325 |
| Intra-Alaskan operations | 2,484 | 3,356 | 4,639 | 4,945 | 4,530 | 3,723 | 3,674 |
| Hawaiian operations | 48 | 715 | 871 | 684 | 293 | 293 | 293 |
| Trans-Atlantic operations | 16,121 | 10.656 | 9,034 | 4,428 | 3,136 | 2,454 | 2,294 |
| Trans-Pacific operations | 10,776 | 11,641 | 12,173 | 11,357 | 2,737 | ..... | ..... |
| Latin-American operations | 10,245 | 14,511 | 15,471 | 16,207 | 12,759 | 9,811 | 9,862 |
| Total | $76,657 | $68,355 | $70,741 | $72,036 | $55,728 | $48,719 | $48,446 |

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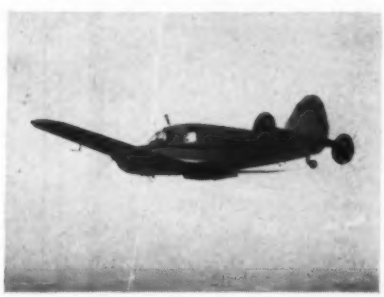

In flight the gear is retracted to fit snugly under the wing where it will have little effect on the performance of the airplane.

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gold francs) liability limit will not apply. The new no-limit clause is restricted in favor of the carrier.

The old clause said the limit would not apply to a carrier "if the damage was caused by his wilful misconduct or by such default on his part as, in accordance with the law of the court to which the case is submitted, is considered to be equivalent to wilful misconduct." Various interpretations of the phrase "wilful misconduct" have led to considerable litigation in the past.

New wording states that the limit will not apply "if it is proved that the damage resulted from an act or omission of the carrier, his servants or agents, done with intent to cause damage or recklessly and with knowledge that damage would probably result; provided that, in the case of such act or omission of a servant or agent, it is also proved that he was acting within the scope of his employment."

## New Airport Policies Given in CAA Manual

Policies and procedures for administering the amended Federal Airport Act have been finalized by the Civil Aeronautics Administration. The four-year contract authorization provision is the bill's principal feature. It will allow long-range programming on large developments and "will assist each community, irrespective of population . . . having a substantial aeronautical re-

*(Continued on page 177)*

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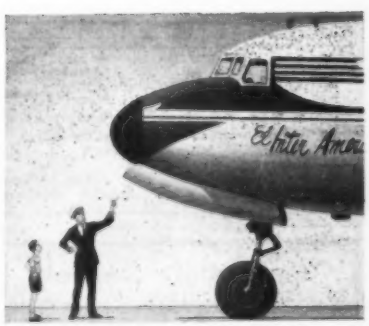

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*(Continued from page 174)*

quirement, in developing new or bringing its existing civil airport to a standard compatible with the present and future needs of civil aeronautics."

Copies of the manual, which details the policies, procedures and eligible items, are on sale by the U.S. Department of Commerce and its field offices at 50¢ per copy.

## Lockheed Extends Range Of Turboprop Electra

Lockheed's new Electra turboprop now on order by both American and Eastern Air Lines has "grown into a 3,000-mile aircraft capable of transcontinental non-stop operation.

Changes to the Electra wing, principally involving an increase in wing area from 1,200 to 1,300 sq. ft. have altered payload-range characteristics, takeoff/landing distances and rate of climb while reducing cruise and block speed by 2-3%.

New figures for the Electra (old shown in parenthesis) are:

Wing span 99′ 0″ (95′ 6″)
Fuselage length 104′ 2″ (102′ 8″)
Height (tail) 32′ 3″ (34′ 0″)
Takeoff gross 110,000 lbs. (99,500)
Landing Weight 93,370 lbs. (89,500)

Cruise speed for the turboprop is now pegged at 410 mph (formerly 414 mph) and top speed exceeds 450 mph.

Maximum range with 60 passengers and 2½ hours reserve fuel is 3,000 miles, permitting transcontinental nonstop in about 6½ hours, Lockheed says.

## Mr. P. Guides Three Clients Through Europe

I've been to Europe again. Stayed five or six weeks. I know, I'm in a rut. I'm ashamed to say it. I keep dreaming about my long-planned trips to the South Seas, and up the Amazon, and around the Belgian Congo, and to Tierra del Fuego, and then I end up bumming around Europe again.

But this trip was different. I can now sympathize with every tour conductor and guide that ever herded a batch of American tourists around from one capital to another. I feel sorry for them.

You see, I worked my way on this last trip as a tour conductor for a small, select group of tourists. Three, to be exact. I never worked so doggoned hard for so little compensation in my life. My pay was a lot of laughs but you starve on those. Once when a waiter misunderstood one of my clients (which was plenty) I got a free martini that was left over. My clients were poor tippers and kept me in my place.

I was tour conductor, bar guide, cultural lecturer, hotel booker, chauffeur, money-changer, baggage handler, night club picker, shopping counselor, target for all jokes and jibes, reservations clerk, menu translater, interpreter, historian and general expert on matters in which my clients were in no position to challenge. So okey, United Air Lines, I've had my lesson and punishment. No more testimonials.

### Distinguished Group

I'll say this, though: my tour group was distinguished. Terry Drinkwater, president of Western, had never been to Europe. We'd been talking about this trip for ten years so all of a sudden in mid-summer I got a call from Terry saying he was ready to go, so how about it. I said sure, why not but, where to, when, for how long, and so forth. He said "Fix it up—you're the tour conductor." For a full five minutes I was glowing with flattery and pride. Then the headaches started.

The other clients were Stan Shatto, Western's v.p.-operations, who had never been to Europe, either, and whose quiet, retiring demeanor is a very misleading glossy coating to a dynamic interior; and Mr. Harry J. Volk, a Western director who is western v.p. for Prudential Insurance Company in Los Angeles and who is one of the most delightful, witty and tireless guys I've ever had the privilege of knowing. Harry Volk had been to Europe before but never to Scandinavia.

So that's how it all began. Drinkwater and Shatto flew the Scandinavian Airlines System polar route from Los Angeles to Copenhagen. Harry Volk and I took an SAS Royal Viking from New York to the Danish capital, arriving a few hours after the polar flight, and the four of us proceeded to Stockholm where the hospitality and deluxe treatment began and didn't end until some weeks later, as we progressed back to Copenhagen and on to Hamburg, Berlin, Amsterdam, Brussels, Paris, London and all intermediate points. Thanks to a batch of European airlines, especially, the tour was royal from first to last.

Oh no, not again!

### What, No Notes?

As with all my trips I began keeping a few notes. But being tour conductor leaves no time for note-taking; at least that's my excuse. I've never come back to the office with as jumbled a bunch of scribblings, so any reports on this trip will be in bits and pieces.

I'm only speaking for myself, since my clients deported themselves as dignified, polished gentlemen throughout, interested only in airline bases, cathedrals, museums, historical buildings, and the like, you know how it is, but I can confess that somewhere along the route, I think it was in Berlin, I dashed off a note to my wife and addressed the envelope to a house in which we have not lived for eight years.

I'm not going to reprint the first paragraph of the reply from my wife suggesting to me in rather caustic words that she would get her mail somewhat faster if I'd remember where I lived, but I can report that my reputation in the neighborhood is somewhat enriched (but hardly enhanced) due to our postman's proclivities for passing on gossip up and down the street.

Anyway, it was a fine trip.

As for the photo on this page, this is a typical example of the trials of a tour conductor. Seems that we were wandering around the Grand Place of Brussels looking at the magnificent medieval buildings and Drinkwater is approached by one of the town guides. Immediately there's a transaction. For the sum of 300 Belgian francs ($6.00), much more than the hat was worth, Drinkwater buys the cap and turns it over to me.

I had every intention of ditching the hat somewhere but a daily tab of it was kept by my clients. The photo was taken on our terrace at the Hotel Prince des Galles in Paris. The last we saw of the Brussels guide he was still bareheaded.

### The Scandinavian Touch

Before I wander too far from the subject, I want to pay a high compliment to SAS for its Royal Viking service. Both going and returning, the service was first class in every respect. Instead of featuring certain deluxe flights, SAS has maintained ever since 1946 a daily single-standard first class flight with all the comforts one can find in an airplane. Lots of room, and the service isn't over-done.

SAS has provided a Scandinavian touch to the American way of doing things and you don't have to worry about what day you travel on to get the best service; it's standard every day.

For this trip I did a little experimenting with luggage. Having been attracted by the ads for the new Koch fibreglass line, I bought a two-suiter to see how well it stood up. Not only is fibreglass strong, but instead of lock and key, Koch uses a combination lock nicely imbedded in the top. The latter is a good innovation except for those who can't remember the combination and I can conceive of such difficulties on occasions.

But within one week of starting out with the bag, one of the closing snaps broke right off. It was on the sidetrip to Berlin but I can't prove whether it happened on the airline or on the ground. In any event, the aluminum catch broke off sharply. By good luck and the use of one snap and the combination lock, the bag held together for the remainder of the trip.

The snaps are a weakness in the Koch bags. They aren't strong enough and they bulge out. They need some streamlining and strengthening. I got mine fixed (cost, $2.50) after I returned and otherwise I'm satisfied that the fibreglass luggage is in the upper brackets for hard travel if the one weakness can be corrected.

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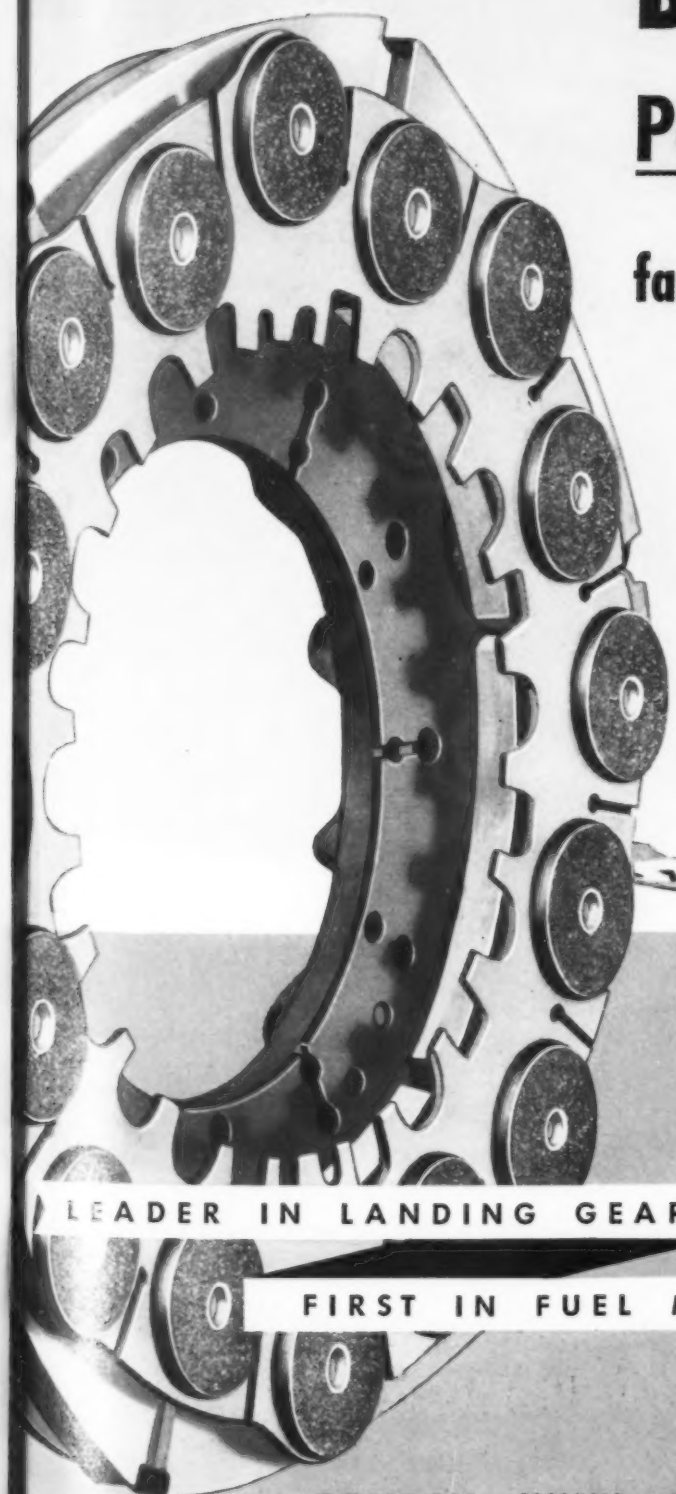

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